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ENVIRONMENTAL ASSESSMENT for the PROPOSED RE-USE ALTERNATIVES of GLASGOW AIR FORCE BASE

VOLUME I

The Montana Energy and MHD Research and Development Institute, Inc.

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Butte, Montana 59701

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ENVIRONMENTAL ASSESSMENT
for the
PROPOSED RE-USE ALTERNATIVES
of
GLASGOW AIR FORCE BASE

VOLUME I

prepared by

THE MONTANA ENERGY AND MHD
RESEARCH AND DEVELOPMENT INSTITUTE
P. O. Box 3809
Butte, Montana 59701

prepared for

OLD WEST REGIONAL COMMISSION

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ABSTRACT

This document represents the final report on an environmental assessment conducted on potential re-use alternatives for Glasgow Air Force Base. The surplus federal facility, located in the northeastern corner of the state of Montana, was studied in regard to the following re-use scenarios:

1. Gasohol/Ethanol Plant;
2. Modular Housing Fabrication Facility;
3. Rail Car Repair Facility;
4. Wind Electric Power Production and Wind Turbine Manufacturing Center; and
5. Coal Gasification Plant.

The evaluation consisted of describing the technical processes involved, analyzing the economic viability of each alternative, delineating the legal requirements, and assessing the environmental and social impacts of the potential projects. The results of this assessment indicate that, with the exception of siting a coal gasification plant at the base, there are no significant negative environmental or social impacts or legal obstructions anticipated with implementing the proposed re-uses. The technical and economic merits vary for each re-use suggested and are discussed in the report.

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I. INTRODUCTION

I.1 Contract Background Information

The Montana Energy and MHD Research and Development Institute (MERDI) received a contract in July 1977 from the Old West Regional Commission (OWRC) to conduct an energy-related feasibility study and prepare an environmental impact statement for the re-use of Glasgow Air Force Base (GAFB) in Valley County, Montana. This was a companion contract for work being done by the Montana International Trade Commission (MITC) for the U.S. Department of Commerce for the evaluation and implementation of redevelopment alternatives for the base. The original source of funding for these two contracts was the U.S. Department of Defense (DOD) which, at the present time, intends to dispose of the base by the summer of 1979. One of the main objectives of these two contracts was to "find" economic activities suitable for the base so that, if and when the base is disposed of, the facilities would be utilized to benefit the community.

Under its contract, MITC investigated nine specific re-use alternatives in addition to others it developed on its own initiative. The engineering and economic information that MITC generated was given to MERDI for further environmental and economic feasibility evaluation. In addition, one of MERDI's tasks was to develop alternative renewable energy re-use concepts. All of these re-use concepts have been analyzed, and four were selected as the most suitable and with the highest probability of becoming a reality. In addition to these four re-uses, MERDI was directed by DOD to investigate the feasibility of siting a large coal gasification facility at the base.

MERDI also was contracted to provide a Montana energy model and to establish the baseline characteristics and conditions for the environment surrounding GAFB, as necessary for the preparation of an environmental impact statement. These two tasks comprised a significant portion of the effort to identify re-use alternatives; however, these tasks are not directly included in this final report. They are reported upon in full in independent reports and included as primary references to this document.

A few months before the end of the contract, MERDI was directed by DOD through the OWRC to reduce the man-hours and dollars used in the contract. Because of this direction, the depth of the analysis on the five re-use alternatives studied was reduced and the requirements to produce a draft environmental impact statement (EIS) and supply support for public EIS meetings were eliminated. The contract objective was limited to the equivalent of conducting an environmental impact assessment at a slightly reduced level.

This final report provides a description, analysis, and evaluation of the five re-use alternatives selected:

1. Gasohol/Ethanol Plant;

2. Modular Housing Fabrication Center;

3. Rail Car Repair Facility;

4. Wind Electric Power Production and Wind Turbine Generator Manufacturing Center; and

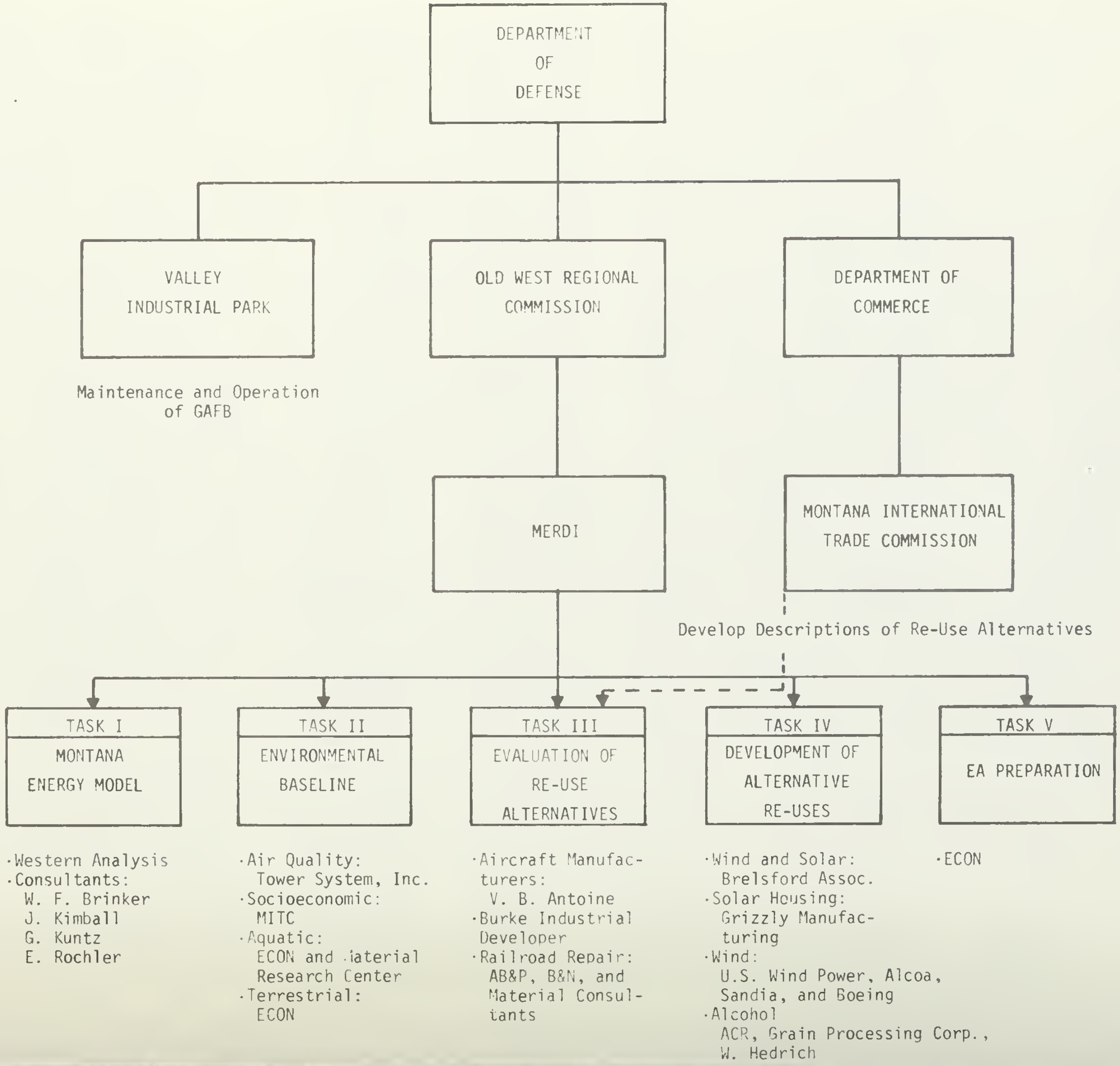
5. Coal Gasification Plant.

I.2 Project Methodology

As indicated in the previous section, the contract objective for a large portion of the contract period was to develop a draft EIS for the re-use of GAFB. This was changed later to the equivalent of an environmental assessment (EA). This change did not cause a major redirection of the work effort although the depth of the information developed in each re-use was also directed to be reduced. In accomplishing the contract objective, June 1978 guidelines developed by the Council on Environmental Quality (CEQ) on the preparation of environmental assessments have been followed. These guidelines establish the necessity for logical, concise EA and EIS preparation, resulting in documents which are brief and well written. In addition, an analytical approach, in which only pertinent data is reported, is preferred to an encyclopedic approach, in which data is reported regardless of relevance.

In accomplishing the assigned tasks in the spirit of the above direction, MERDI has obtained assistance from other organizations and individuals. Figure 1 shows a partial, but representative, listing of organizations and individuals that have contributed information under each task. In addition, extensive use has been made of published literature, reports, and personal conversations. "Pride of authorship" was not a factor in the selection of any re-use. MERDI has evaluated all reasonable re-uses regardless of the source. Sufficient flexibility has been maintained in the management of the contract so that the list of recommended re-uses was kept open until August 1978. The evaluation of each re-use considered followed the same process.

The first step was to establish a clear understanding of the proposed re-use and identify the major elements. This information was presented to the MERDI review team for initial assessment. If approved for further study, a re-use project manager was assigned who was responsible for developing additional detailed information and assessing the business support required to initiate the re-use and the impact that the re-use would have on the surrounding community. After this study was complete, the results were presented to the review team for comparison with other re-uses. The review team ranked the re-uses and estimated the amount of additional resources and efforts that would be required to generate sufficient engineering and economic details for complete assessment and packaging of the re-use for "marketing" by VIP. The next step was a presentation to the VIP board and staff of the highest ranked re-uses. The number of re-uses that could be carried forward after VIP approval was limited by the funds available. In May 1978, the five re-uses described in this report were presented to VIP and approved. Since that date, all work has been directed toward finalizing the description of these re-uses and performing the assessments. The scope of work that MERDI has been contracted to perform is limited to description and assessment. VIP is responsible for "selling" the base and signing tenants under a contract.


DEPARTMENT OF DEFENSE
VALLEY INDUSTRIAL PARK
Maintenance and Operation of GAFB
OLD WEST REGIONAL COMMISSION
DEPARTMENT OF COMMERCE
MERDI
MONTANA INTERNATIONAL TRADE COMMISSION
Develop Descriptions of Re-Use Alternatives
TASK I
MONTANA ENERGY MODEL
·Western Analysis
·Consultants:
W. F. Brinker
J. Kimball
G. Kuntz
E. Rochler
TASK II
ENVIRONMENTAL BASELINE
·Air Quality:
Tower System, Inc.
·Socioeconomic:
MITC
·Aquatic:
ECON and Material Research Center
·Terrestrial:
ECON
TASK III
EVALUATION OF RE-USE ALTERNATIVES
·Aircraft Manufacturers:
V. B. Antoine
·Burke Industrial Developer
·Railroad Repair:
AB&P, B&N, and Material Consultants
TASK IV
DEVELOPMENT OF ALTERNATIVE RE-USES
·Wind and Solar:
Brelsford Assoc.
·Solar Housing:
Grizzly Manufacturing
·Wind:
U.S. Wind Power, Alcoa, Sandia, and Boeing
·Alcohol
ACR, Grain Processing Corp., W. Hedrich
TASK V
EA PREPARATION
·ECON

The final disposition of GAFB will be decided by the General Services Administration (GSA). At the present time, the transfer of the base to Valley County for aeronautical use is the most probable disposal action to be taken by GSA. Landrum and Brown Aviation Consultants (Landrum 1977) has studied the aeronautical re-use and identified that suitable industrial business or service functions and organizations are probably necessary to generate income in order to maintain the base for aeronautical use. In support of this, MERDI has tried to provide as many re-uses as possible with the funds available. Once the final GSA action has been taken or has been publicly announced, VIP will be in a position to offer possible tenants long-term agreements for the use of base facilities. The five re-uses presented in this final report are the best candidates developed or suggested as of September 1978 in the opinion of MERDI and VIP.

1.3 Glasgow AFB Characteristics

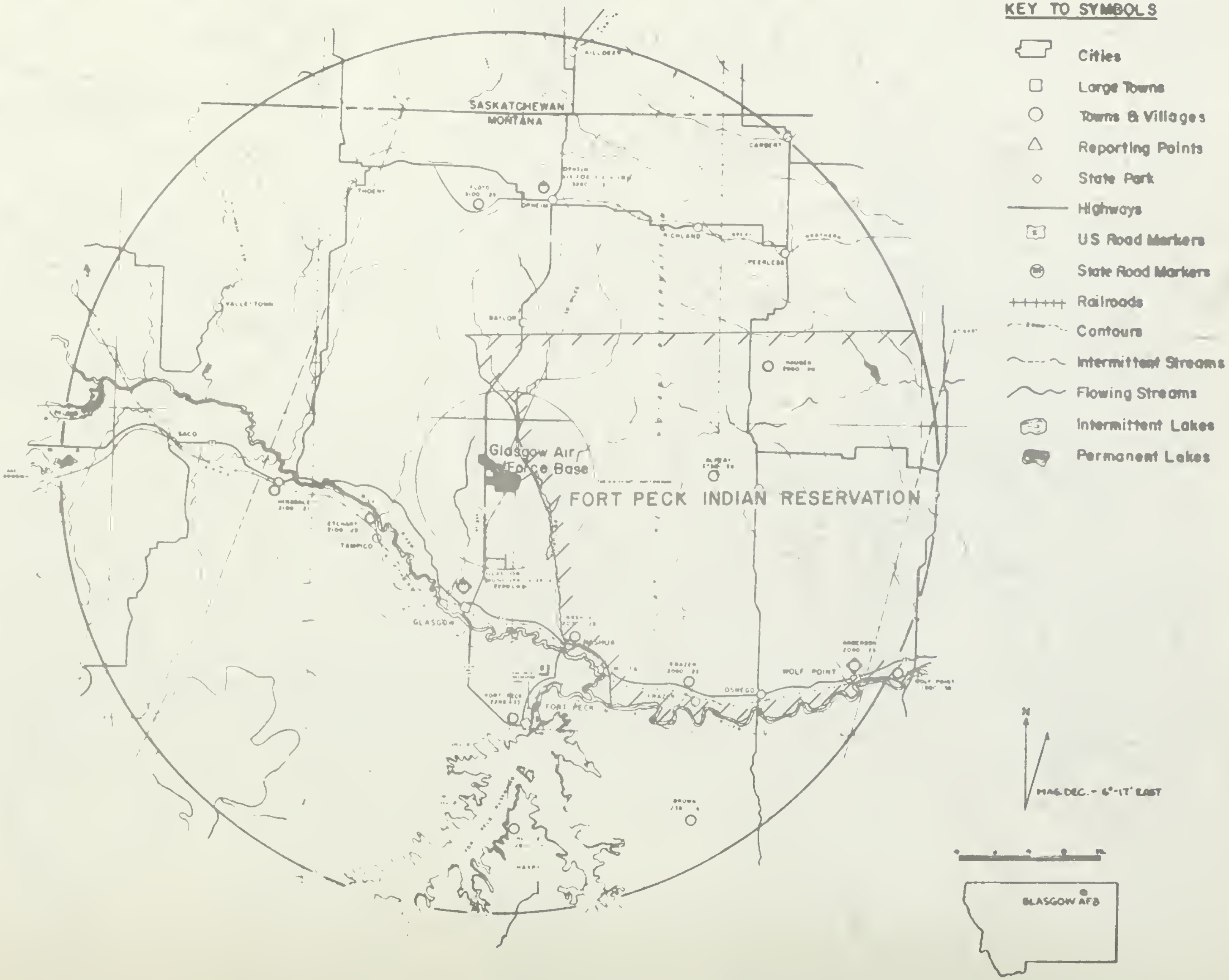
Glasgow AFB encompasses 5,582 acres of land and is located in the northeastern corner of Montana approximately 40 miles south of the Canadian border. The largest city within approximately 150 miles is Glasgow, Montana, which is 18 miles south of the base (see Figure 2).

The base (see Figure 3 for an aerial view) was activated in 1957 and was closed for the first time in 1968. During this period, it was used as a USAF Air Defense Command base and then as a Strategic Air Command base. In addition to a 13,500 by 300 foot primary aircraft runway (which will support 580,000 pound total loads) and the supporting taxiways, the base contains supporting logistics and housing facilities such as the following:

1. 1,260 family housing units;
2. 14 dormitory buildings;
3. elementary and junior high schools for 960 pupils;
4. 50-bed hospital and dental clinic;
5. shopping and recreation facilities;
6. 40 office, hanger, and maintenance buildings; and
7. water, sewer, power, and fuel storage facilities.

The total value of all facilities, which are permanent, was $88.7 million at the completion of construction.

The base was reactivated for a few years to support the Safeguard Missile System, during which time improved electronic system storage and maintenance facilities were provided, and closed again in 1976. Since the last closing, the base has been maintained in excellent condition by Valley Industrial Park, Incorporated (VIP), an agent of Valley County under con-



Source: Strategic Air Command

Figure 2.--Glasgow AFB Regional Map

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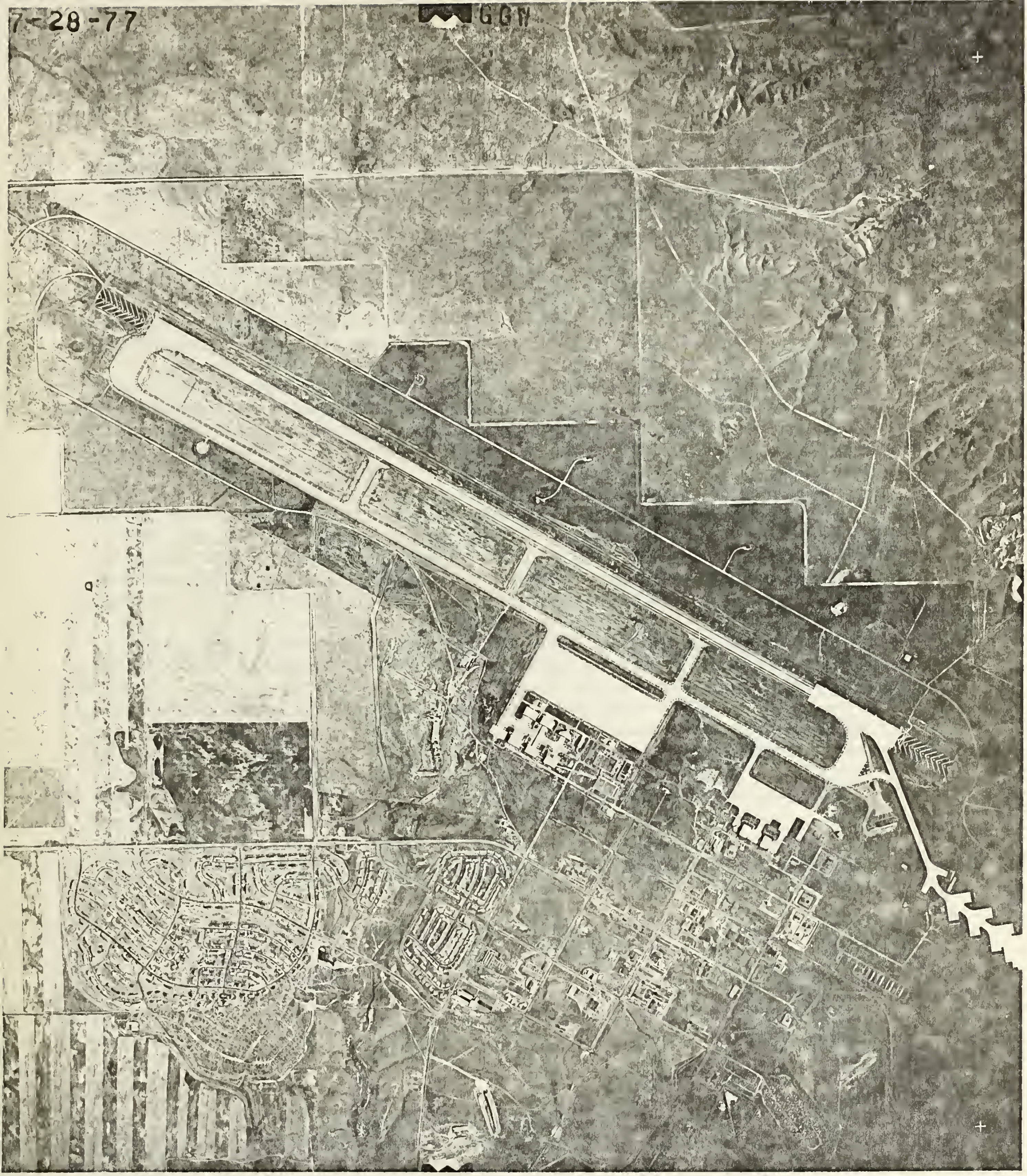


Photo courtesy of
ECON, Incorporated
Helena, Montana

Scale: 1 inch = 2100 feet

Figure 3.--Aerial View of Glasgow Air Force Base

tract to DOD. In addition to its caretaker role, VIP has been authorized to lease the base facilities. The major tenant is the Family Training Center which provides training for over 100 students and their families from Montana and surounding states.

I.4 Study Area Characteristics

In order to assess the suitability of any re-use, the environmental and socioeconomic impacts must be considered for the base and the surrounding area. In general, northeastern Montana has environmental characteristics that are similar to other regions in the northern Great Plains: slightly rolling open grasslands with approximately fourteen inches of annual precipitation, soil with limited crop productivity, and very few woodlands. Although the area has soil limitations, it is emphasized that a very progressive agricultural community in this area has made Valley County the fourth most important agricultural producer in Montana. The primary mineral resource is lignite coal which can be surface mined. The dominant geographic feature in the area is the Missouri River and the Fort Peck Reservoir which is approximately 45 miles south of the base. Depending upon the weather conditions, there is an average number of deer and antelope and a substantial population of game and non-game birds in the region.

Glasgow AFB is located in the middle of Valley County; and its characteristics are representative of the entire study area. The primary economic activities are those associated with ranching and farming and the supporting services. There are slightly more than three million acres in Valley County: 35 percent is privately owned, 48 percent is federally owned, 7 percent is state owned, and 10 percent is owned by the Fort Peck Indian Reservation which is just east of GAFB. About 700,000 acres are used for cropland and only a small fraction is irrigated. Over two million acres are rangeland which is used in varying degrees for grazing. The current county population is estimated at almost 15,000 with over 6,000 residents living in Glasgow. A major east-west railroad and highway traverse Glasgow, and a secondary road system serves the county.

An indepth environmental data base was established for the region within a 20-mile radius by MERDI, and socioeconomic data was collected from a 250-mile radius of the base by MITC. Detailed discussions of che regional characteristics are provided in Appendix A. Using this information, impact assessments were performed and descriptions of the re-use alternative were developed by MITC and MERDI.

I.5 Report Contents

The project methodology used to arrive at the assessment report is provided in Chapter II, and the five re-use descriptions and assessment reports comprise Chapter III. The assessment reports on each re-use cover five elements: technical description, economic analysis, legal requirements, environmental impacts, and social impacts. Chapter IV concludes the report with discussions and conclusions on the five suggested re-uses.

There are two levels of appendix material which supplement the report. The first level, included at the end of this report, is designated

Appendix A through Appendix D. Appendix A contains a description of the physical overview of GAFB and vicinity and summary information depicting the general area, ecology, meteorology, hydrology, geology, soils, and vegetation. A summary of the legal requirements for all five re-use alternatives is contained in Appendix B. In Appendix C, details of the environmental and social impacts associated with each re-use description are given. A Leopold matrix, which is a visual summary of this data, is shown for each proposed re-use. The results of an attitudinal survey conducted by MERDI to obtain community input on the proposed re-uses are presented in Appendix D.

Second-level appendix material, designated as Appendix E, is contained in a separate volume. This appendix contains materials referenced throughout the main text and Appendices A through D.

I.6 Use of Report

During the past few years, many studies on possible re-uses of GAFB have been performed. These studies have all been reviewed and analyzed for applicability in 1979 as part of this project. Elements of some of the re-uses described in this report have been presented before. It was not the intention of this contract to present only new concepts but rather to present the best re-uses with the highest likelihood of being implemented. A variety of re-uses are feasible from those which can be started with local resources to those which require a major commitment from a large corporation. This report and the appendices provide sufficient information for any interested individual or group to formulate a business plan and start a business which encompasses some of the re-uses suggested. The information on the other re-uses can be used by the County Commissioners or VIP to identify the necessary business conditions and business environment for that activity to be successful and to "sell" GAFB facilities to an appropriate investor.

II. GAFB RE-USE EVALUATION METHODOLOGY

II.1 Introduction

As stated in the Contract Background Information Section, the objectives of this aspect of the project were to identify potential re-uses for GAFB and to determine the viability of each identified re-use based on technical, economic, legal, environmental, and social aspects. Because of the broad and detailed scope of work necessary to accomplish the objectives, expertise from several disciplines was required.

From the many potential re-uses identified for GAFB, five were chosen for detailed study. The contract sponsor specified studying the coal gasification re-use, and the four remaining were chosen as specified in Section I.1. Each of the five re-uses were evaluated in terms of technical feasibility, economic potential, legal constraints, environmental impact, and social impact and acceptability. To analyze the proposed re-uses thoroughly, a specific evaluation methodology for each discipline was followed.

This section of the report is provided to briefly discuss those methodologies, giving simplified accounts of the re-use evaluation processes. It should be kept in mind that evaluations in each discipline were not made independently of one another. Checks were made and data were shared by the various investigators to ensure continuity in each approach taken. Frequently, the re-use suggested could be evaluated using more than one technical or economic approach; therefore, discussion was necessary to decide which technical or economic approach should be used for a particular re-use alternative.

II.2 Technical Evaluation Methodology

Once a specific re-use had been identified as having the potential for application at GAFB, a detailed technical review of the proposed re-use was undertaken. This evaluation varied somewhat for each suggested alternative depending on the nature of the re-use and the data that was available for the study. Generally, the technical evaluation was conducted using the procedure discussed below.

The state-of-the-art for the proposed re-uses was reviewed, and contacts were made with similar commercial installations if appropriate. This included a review of manufacturing or processes currently in the Montana market or elsewhere in the United States. Comparisons were made between the various manufacturing or processes in operation or proposed for operation, and a decision on which would be the most suitable for use at GAFB was made. The technical details developed were used to determine the scale of operation, necessary equipment, and required manpower. These data then were used in conducting an economic analysis, and the detailed process or manufacturing descriptions were used to provide data for the environmental and social impact evaluations.

II.3 Economic Analysis Methodology

One criteria that any potential commercial re-use of GAFB must meet is its economic viability. That is, a market must exist for the product or service offered, and the price at which it is offered must be competitive with similar or substitute goods and services.

The economic evaluation made for the proposed re-uses included a market analysis to determine what price the commodity could bring and the extent of the demand for that item. Secondly, the costs associated with producing the product at GAFB were made. This evaluation included the additional costs associated with transporting raw material from a source or transporting manufactured goods to the market. Credit was given for any capital advantages that the facilities at GAFB could offer a proposed re-use. Analysis of future market and costs also were made as necessary, and capital requirements to initiate the re-use and employment levels that might result were determined.

II.4 Legal Requirements Methodology

Once a potential re-use had been chosen for evaluation and a technical approach established, a survey was made of state and federal laws relevant to each re-use alternative. Computer reference data was used, and literature was surveyed to compile summaries of the applicable laws, permit regulations, standards, etc. The compiled information then was applied to each particular re-use alternative.

II.5 Environmental Impact Methodology

To assess the environmental impact of each re-use alternative, baseline data on the ambient GAFB environment was reviewed in conjunction with the development of technical descriptions detailing the proposed re-uses. Baseline study data collected on-site specifically for the contract included information on the aquatic environment, terrestrial wildlife, terrestrial vegetation, and meteorological data such as wind, solar, temperature, etc. Other literature pertaining to the re-use alternatives (academic studies, corporate documents, environmental impact statements, etc.) also was reviewed. A preliminary analysis was developed, and through discussion with the various project members, qualitative descriptions were developed and quantified. Using the Leopold Assessment Methodology, visual abstracts were prepared to reflect the information developed. From the data accumulated, detailed technical environmental impact predictions were made.

II.6 Social Impact Methodology

To evaluate the potential impact on the social structure of Valley County, it was necessary to consider the various elements which could be affected by each re-use scenario (e.g., labor force, education, welfare/unemployment, medical facilities, business, etc.). Current data on the area's statistics were compiled, and projections were made regarding the potential impact of each re-use. Possible mitigating measures also were defined. To assess attitudes and opinions toward growth and development of Valley County (see Appendix D for methodology discussion), an attitudinal survey was personally administered to a randomly selected sample of Valley County residents. Key agencies and organizations in the county were requested to prepare letters stating how they could be impacted by the various re-use scenarios (see Appendix E, Section 4 for an exhibit of the letters). A similar technique was used to assess the possible impact on the members of the Sioux and Assiniboine Tribes residing on the Fort Peck Reservation. The Tribal Councils prepared letters expressing their views on the proposed re-uses.

III. DESCRIPTION OF GAFB RE-USE ALTERNATIVES AND IMPACTS

III.1 Introduction

During the course of this project, many potential re-uses of GAFB were considered. From those considered, five were chosen for detailed analysis. They are discussed in this section in the order listed below:

1. Gasohol/Ethanol Plant;
2. Modular Housing Fabrication Center;
3. Rail Car Rapair Facility;
4. Wind Electric Power Production and Wind Turbine Generator Manufacturing Center; and
5. Coal Gasification Plant.

Each of the re-use alternative descriptions consists of a process or manufacturing description and an economic analysis. The legal, environmental, and social impacts of implementing each alternative also are presented. The discussions provided for these topics are summations of background material which resulted from work performed in this project and from other pertinent reference material.

The level of detail at which each of the re-uses was assessed does not necessarily reflect the level of feasibility of a suggested alternative. Rather, the discussions vary in length and detail because of the following reasons.

1. The scale and complexity were significantly different for some of the re-uses evaluated. Therefore, the level of examination required to quantify the impact or feasibility of each approach varied. For example, examination of the environmental impact of siting a coal gasification plant was considerable, while the environmental impact assessment of the proposed modular home fabrication facility was much less involved.

2. Some of the proposed activities are conceptual and have not been tried or considered previously. Therefore, only the scope and feasibility of the project were discussed. Information that was available or could be devised was analyzed and reported on.

3. Some projects have a higher probability of success than others, due to technical and economic feasibility, environmental compatibility, and social preference. Therefore, these projects were pursued in as much detail as possible.

III.2 Gasohol/Ethanol Plant

III.2.1 Introduction

The production of liquid fuels from renewable energy sources as a supplement or replacement for petroleum fuels is the subject of much national interest. The government has renewed research activities in this area, and many groups around the country have organized to promote the production of liquid fuels from grains and other cellulose materials. One method for producing liquid fuels from renewable sources involves the conversion of grains into alcohol, which can be mixed up to 15 percent with gasoline and used in gasoline burning engines without requiring any hardware modifications or adjustments. Higher alcohol to gasoline ratios are suitable for use in internal combustion engines with carburetor adjustments.

Development of a capability to manufacture significant amounts of liquid fuels from renewable resources, if only to provide fuels for a specific segment of the society such as agricultural producers, has significant merit since it serves to reduce our import dependence and provide the potential for a segment of our society to possibly become energy self-sufficient.

The establishment of a gasohol plant at GAFB is an excellent choice for a re-use of that facility since it would directly benefit the agricultural community in Valley County. The scale of the operation proposed for GAFB is small enough to allow for community control and operation. This facility would provide a technology that is valuable to the agricultural community since it would allow the community to produce liquid fuels needed to operate machinery, provide a reliable market for grains currently produced, pioneer an industry that might be an important source of energy in the future, and yield a protein feed for livestock.

The following gasohol/ethanol plant description is based on a completed process design developed by John Chambers[1] of the ACR Process Corporation. It incorporates several patented design features which significantly reduce energy consumption and simplify the process of removing the last traces of water from the alcohol. This new process produces a mixture of alcohol (75 percent) and gasoline (25 percent).

The development of the overall operation of the plant, including its logistics, has been carried out in close consultation with members of the Montana Agri-Processors Corporation of Valley County which is seriously considering building an alcohol plant. This aspect of the business has greatly benefited from the corporation's intimate knowledge of local resources and conditions.

---

[1] John Chambers is an internationally recognized expert in the design of plant and process schemes for the production of alcohol. He holds an exclusive patent on the process proposed for use at GAFB (ACR 1978).

A building at GAFB (No. 945), which is not used at present, has been identified as being particularly well suited to this project. The proposed plant has been designed to utilize this site.

Two different plant process designs and two different plant sizes have been considered for use in this project. The two process designs are designated as a batch cooker process and a continuous cooker process. There are only slight variations in these two process configurations, and these differences are discussed in the plant and process descriptions section below. The two plant descriptions given vary in alcohol output and capital investment. The larger plant is estimated to cost $1,699,100 and has an annual ethanol production of 1,200,000 gallons, while the smaller plant was estimated at $640,000 and has an ethanol production of 480,000 gallons per year. In these discussions, the larger plant is described using the continuous cooker process, and the smaller plant is presented using a batch process to produce ethanol. The production costs for ethanol from each plant are $0.78 and $0.94 per gallon, respectively. It is important to note that either the batch process or the continuous cooker process can be adapted to either plant size. If the large continuous cooker plant were to be changed to a batch process, slight reduction in capital investment would result. If the smaller process plant were to be changed to a continuous cooker process, some increase in capital investment would result. The two plants described in this report offer a range of plant sizes and plant processes that bracket the high and low capital costs that could be expected. Discussions of coupling the gasohol plant with a feed lot and methane gas generation is provided in Section 1 of Appendix E. The concept is referred to as an Integrated Agricultural Facility.

III.2.2 Process and Plant Description

Introduction

Process and plant descriptions for the proposed facility are presented in this section. A summary of the plant operations is also provided. Two different plant designs have been considered for potential application at GAFB. Both plant designs essentially are configured similarly but have a slight difference in the process operation, and each is scaled differently. One design is configured to have a continuous cooking process, while the other utilizes a batch cooking process to produce the desired product. For ease of discussion, the continuous cooking plant will be detailed in the process and plant sections. The batch cooking process design will be briefly discussed in these sections, and a cost analysis of both plants is presented in the economic analysis section of the report. These options offer the opportunity for the greatest flexibility in suiting northwest Montana's set of product needs and agricultural and economic constraints.

Process Description

The process for producing gasohol is essentially identical to other processes that produce ethanol by fermentation of grain. The flow diagram shown in Figure 4 is provided to supplement the following discussion on the plant process. Grain is moderately ground to a coarse texture, mixed with water and a small quantity of malt, and then cooked. The malt is used to

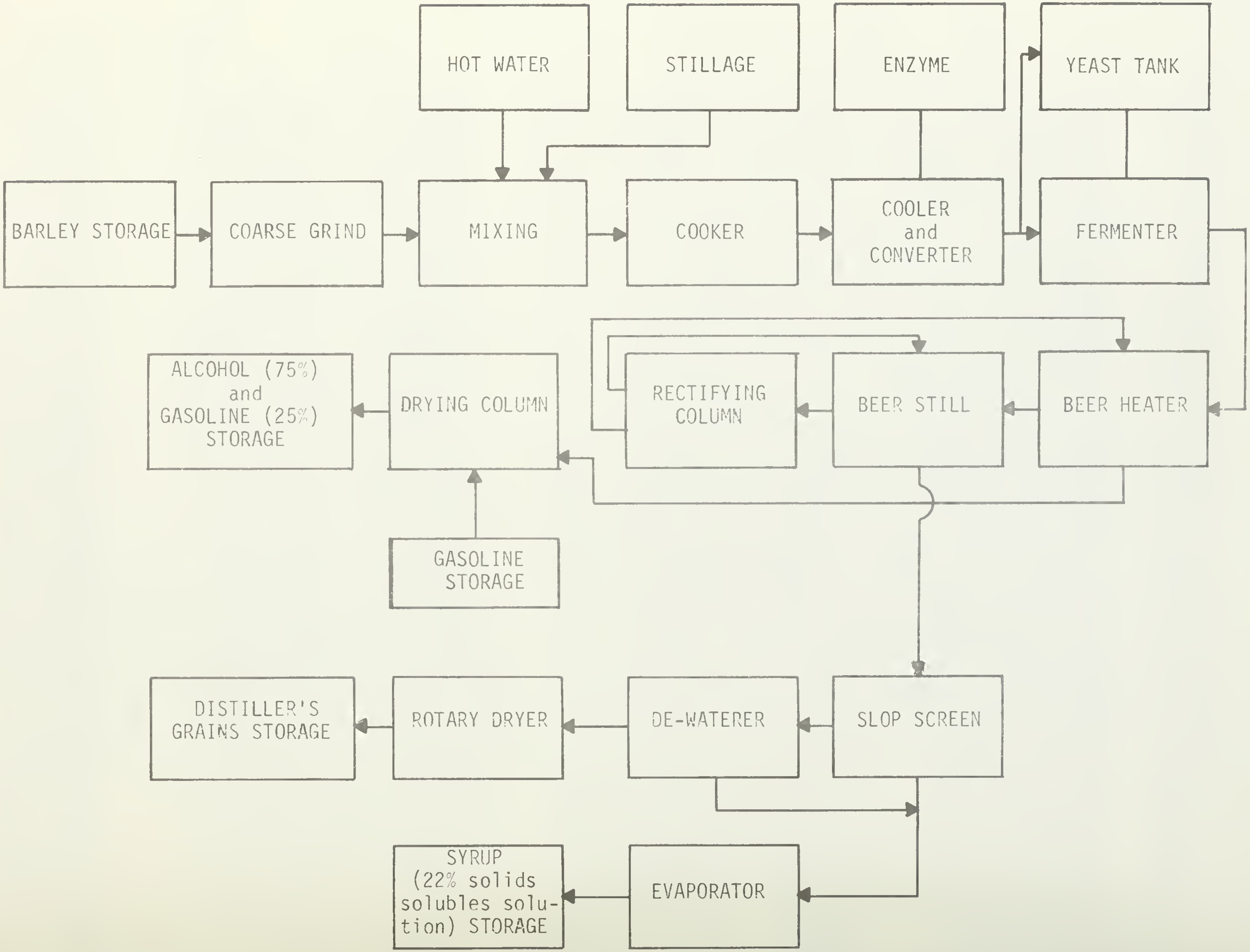


Figure 4.--Ethanol Plant Flow Diagram

minimize the thickening of the cooked mash. The cooking ruptures the cells containing starch so that the water can saturate all of the starch. In this process, the cooking is done under pressure at moderately high temperature (about 350°F) for a very short time. There is a continuous flow of mash through the cooker which is discharged into a vessel at near atmospheric pressure. The sudden decrease in pressure assists in the rupture of the starch cells and results in rapid cooling through the vaporization of part of the water. The resultant steam is used in another part of the process. The mash is cooled further in a heat exchanger to a temperature of about 140°F at which point an enzyme is added which converts the starch to sugar. The enzyme may be purchased or it may be supplied in the form of barley malt. In the latter case, it would be produced at the plant. The mash is held briefly at about 140°F and then cooled to about 80°F and discharged into a fermenter vessel. Most, but not all, of the starch has been converted to sugar at this point. The action of the enzyme continues in the fermenter until virtually all of the starch has been converted into sugar. Special strains of brewer's yeast are added to the mash in the fermenter. These are grown in smaller fermenters supplied with a small amount of the mash. The mash is agitated while in the fermenter where it remains for about three days. During this time, about one third of the weight of the grain is released as carbon dioxide. This is very pure and may be compressed and liquefied if a market for CO_2 is found near enough to justify the cost of the necessary equipment. Otherwise, it is discharged into the atmosphere from which the plants use it in the process of growth. When the fermentation is complete, the liquid in the fermenter, which is called beer, is withdrawn and pumped to the beer still. The liquid contains about eight percent ethanol. The conversion of the starch (via sugar) to alcohol will be at least 90 percent of theoretical. Some proteinaceous components of the grain will be in solution in the water, as will some enzymes. The greater part of the proteinaceous material and the fiber will be in suspension since only the starch is finally converted to alcohol. The combined dry weight of the dissolved and suspended solids is about one third of the weight of the grain. The alcohol comprises the remaining third.

The process of distilling the alcohol from the remainder of the beer begins in the beer still. The alcohol and some of the water are evaporated as the beer flows downward through a series of perforated plates in a tall column. The heat of evaporation is supplied by steam introduced at the bottom of the beer still. The greater part of the water with its dissolved and suspended solids collects in the bottom of the beer still. The mixed alcohol-water vapor is introduced into the bottom of a rectifying column which is filled with a number of special perforated plates which ensure intimate, sustained contact of the vapors with a downward-flowing liquid stream. This stream is introduced at the top of the column as 190 proof alcohol and in its downward progress absorbs all but five percent of the water from the ascending vapors. This dilute alcohol is sent back to the beer still to join the beer as it is introduced, and it is evaporated along with that of the beer in the beer still.

The 190 proof (94 percent alcohol) vapor from the rectifying column goes to heat exhangers in which it is condensed, giving up its heat to the beer as it flows to the beer still. The 190 proof alcohol then goes to equipment where the remaining water is removed from the alcohol. This is accomplished by the addition of gasoline to the 190 proof alcohol with subsequent distillation. This is similar to well-known processes for removing the water. However, other processes use a pure hydrocarbon rather than gasoline. In order to conserve this expensive hydrocarbon, it is necessary to remove it completely which requires a considerable expenditure of energy. In this patented process, the use of gasoline permits it to be left in the solution with the alcohol and, thereby, reduces the energy consumption. The residual gasoline in the alcohol is completely compatible with the motor fuel and useage of the alcohol. In addition, the gasoline effectively denatures the alcohol, making it unfit to drink. This denaturing step is required by the Alcohol Tobacco and Firearms Bureau. By incorporating this step in the production process, it is not necessary to have the denaturing step supervised by an agent of ATF, and the product can be shipped immediately after it is made.

The liquid from the bottom of the beer still is pumped through a screen to remove the coarser suspended particles and then to a filter press where the remainder of the suspended solids are filtered out. All of the solids are combined and dried in a rotary drum drier using the flue gases from the boiler as a heat source. These are called distiller's light grains. The liquid with the dissolved solids is pumped to an evaporator in which sufficient water is evaporated to make a syrup of about 22 percent solids. The syrup can be dried with the solids to produce dark grains. The syrup and the grains may be used in formulating cattle feed, being valuable sources of proteins and vitamins, and the syrup can serve as a binder to the pelletized feed. Of course, the dark grains also may be used when the binding action is not needed. The dried grains and syrup are stored for shipment to markets as needed.

It should be noted that there is no liquid effluent from this process. The flue gases and some water in the form of vapor are discharged into the atmosphere, but the flue gases are effectively "scrubbed" as they dry the distiller's grains by direct contact.

The steam for the process is supplied by a boiler operating at 175 psi. Some water in the system is lost to the atmosphere in drying the grains. However, the volume of condensate from the concentration of the syrup would be much greater than the boiler make-up requirements and is suitable for boiler feed water. Thus, the only make-up water requirement would be for the water in the syrup and that evaporated from the dried grains. This water may be unsoftened.

The boiler used in the process is fired with coal. An underfeed stoker is used so virtually all of the ash is in the form of relatively large clinkers. These will be disposed of in an approved manner. The boiler can also fire wood chips or pelletized agricultural residues (such as wheat or barley straw). It is equipped with an auxiliary burner which can fire the boiler with either gas or oil. These options serve as a back-up in case of inadequate supplies of solid fuel.

The essential difference between the continuous cooker process discussed above and the batch cooking process is that the batch process is conducted at a lower temperature and requires more time in the cooker than does the continuous cooker facility. One other difference in the two plant processes suggested is that in the continuous process design it has been proposed to dry the distiller's solubles, while in the batch process scheme, the solubles are fed to stock without drying. This process change results in a modification to the facility design allowing significant savings in capital for the batch cooker plant.

Plant Description

This study is based on the alcohol plant being located in Building No. 945 at Glasgow AFB. This is a three-bay hanger; each bay is identical, approximately 80 feet by 100 feet with a roof height of about 40 feet. The long sides of each bay are full-width doors about 30 feet high which open onto broad, concrete aprons.

The layout of the plant in two bays of the hanger is shown in Figure 5. One bay is used for storing materials which need to be kept dry or kept from freezing, i.e., grain, coal, distiller's grain, and distiller's solubles (syrup). The boiler also is located in this bay. An access strip is kept clear at one side of the bay for trucks to enter and load or unload. The dry bulk materials are stored in bins, and the syrup is stored in a tank. Grain is moved from its bin by an auger and fed to the hammermill located at the end of the bin. The ground grain is lifted to the grain hopper in the next bay. The coal is fed to the underfeed stoker-fired boiler by an auger. The boiler is located adjacent to the partition between the two bays, and its flue gases are ducted into the next bay where they are used to dry the distiller's grains. The dried distiller's grains are fed into the bin in the storage bay by an auger. The syrup is piped from the evaporators into the storage tank in the storage bay.

In the plant bay, the cooking and mashing section is adjacent to the storage bay. The fermentation vessels occupy the remainder of the length of the bay and more than half of the bay width. There are eight 16-feet diameter, 18-feet high fermentors and a similar size vessel to receive the contents of each fermentor as it is emptied (the beer well). The beer still, rectifying column, and drying columns with associated heat exchangers, etc. are adjacent to the fermentors and at the end of the plant bay opposite the storage bay. All columns in this distillation section are less than 40-feet high to fit in this bay. The gasoline used in the drying columns and the alcohol-gasoline product are stored in tanks on the apron adjacent to the plant bay. The stillage from the beer still goes to the screen, filter, evaporators, and drier--the flow being toward the storage bay. The dried distiller's grains are fed into the storage bin by an auger, and the distiller's solubles (concentrated to a syrup) are pumped to the storage tank.

Storage is provided for all supplies and products for two weeks of operation. This figure was decided on after consultation with members of

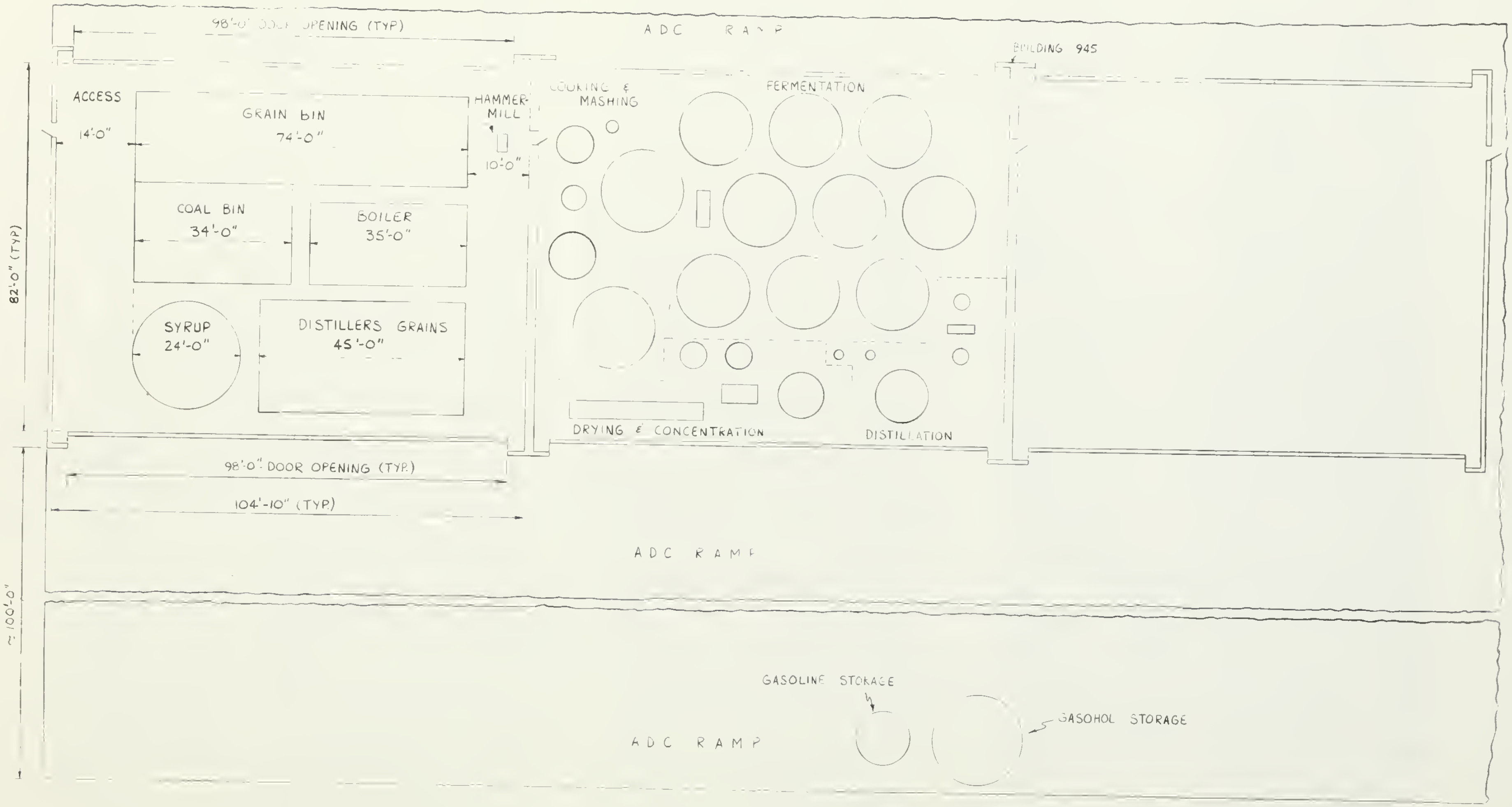


Figure 5.--Gasohol Plant Layout at GAFB

the Montana Agri-Processors Corporation, who said that winter storms had disrupted truck hauling on occasion.

Plant Operation

The continuous cooker plant is designed to process 2,400 bushels of barley per day to produce 4,800 gallons of alcohol and 36,000 pounds of distiller's grains and solubles (dry weight basis). Barley was chosen on the advice of the members of the Montana Agri-Processors Corporation as consistently having the lowest cost per pound and significant yearly production (nearly 2,400,000 bushels in Valley County in 1976). Current bids are as low as $1.45 per bushel, and it is being offered at $1.60 per bushel. The latter figure is used in the economic analysis of this study.

The plant will produce the rated quantity of alcohol in a 24-hour working day with overlapping shifts employing six men. A work week of five days is assumed, resulting in a yearly production of 1,200,000 gallons of alcohol with a two week shut-down for maintenance each year.

The distiller's dried grains and solubles are a valuable, high-protein feed supplement. These products are of great value to cattle feeders but of even higher value for hogs, poultry, or other one-stomached animals. The low proportion of fiber relative to protein and the abundant vitamin B complex have particular value for non-ruminants. The daily production is sufficient for between 6,000 and 18,000 cattle, depending on the proportion used, or for larger numbers of hogs. This can all be consumed within Valley County.

The process requires 1,600 gallons of gasoline per working day, 2,400 bushels of barley, 8.7 tons of coal, and about 18,000 gallons of unsoftened water. Supplies and product alike will be brought to the plant and shipped out by truck. The coal will be brought from Colstrip by semi-trucks once per week and unloaded on Saturday. About four semi-trucks of barley will be needed each week. These deliveries will be made two days each week, one of which ordinarily will be Saturday. Gasoline will be brought in once every two weeks. Product delivery will depend on the timing of the requirements of the market. The production of the alcohol-gasoline product corresponds to one tank truck every three days of operation. It is evident that scheduling will be easy. Solids loading and unloading will be by auger, and liquids will be pumped.

The batch process cooker will utilize 960 bushels of barley per day to produce 1,920 gallons of alcohol per 24-hour shift. The operation will require a four-man crew with overlapping shifts for a 24-hour period. The other requirements for the plant operation, i.e., water, gasoline, and coal, are less in the same proportion for the batch process cooker.

III.2.3 Economic Analysis

Introduction

A cost analysis of two proposed alcohol plant designs are detailed along with a discussion of the value of gasohol for introduction into the market. The batch process plant has a capital cost of about $640,000 with an annual gasohol output of 480,000 gallons, while the continuous cooker has an estimated output of 1,200,000 gallons and an initial capital investment of about $1,699,100. A detailed breakdown of the specific costs for each plant are presented on tables in this section of the report. Production costs for the resultant gasohol product are $0.94 and $0.72 per gallon respectively for the process. Discussions on employment levels required to run each facility conclude the Economic Analysis section.

Cost of Plant

The cost of the alcohol plant is based on quotations for the cost of the process equipment submitted by Vendome Copper and Brass Company of Louisville, Kentucky. At this time, only that company is able to quote the patented process equipment of the ACR Process Corporation design. Mr. Chambers has supplied information on those peripheral items associated with the process, but they are not included in the Vendome equipment quote. The cost of these items, such as tanks, valves, pumps, instrumentation, etc., has been determined from commercial suppliers. Plant design and construction, supervision, erection, and piping costs are based on factors representative of industry experience. The estimated capital cost for the continuous cooker system is about $1,699,100. These costs are shown in Table 1. A significant savings is realized in using the base facility by the absence of site preparation and building costs. The initial capital costs for the proposed batch cooking system are estimated to be $640,000. The equipment costs are shown in Table 2.

Cost of Production

Production costs for both the continuous cooking and batch cooking processes are shown on Tables 3 and 4 respectively. Note that although the initial capital cost of the continuous cooker is much higher, so is the production; hence, the cost of production for gasohol is nominally the same for each process.

A ten-year amortization of a 15 percent loan for the full amount of the capital has been assumed. Should it be possible to obtain financing through Industrial Revenue Bonds, the cost of amortization and interest would be significantly less. If the interest rate is significantly higher, the cost of capital would, of course, increase.

A working capital requirement equal to the value of materials and labor for 12 weeks of operation has been assumed (about $145,000). A rate

TABLE 1. Continuous Cooker Design--Cost Estimate for GAFB Ethanol Plant

Plant design and construction supervision	$ 165,000
Grain grinding and meal storage	15,000
Equipment (pumps, valves, distillation columns, etc.)	524,000
Boiler	160,000
Electric	50,000
Evaporator for stillage	160,000
Dewaterer	30,000
Drier for distillers grain	100,000
Erection and piping	200,000
Storage tanks	42,300
Storage bins	21,200
Laboratory	10,000
Contingency (15%)	221,600
TOTAL	$1,699,100

TABLE 2. Batch Cooker Design--Cost Estimate for GAFB Ethanol Plant

Plant design and construction supervision	$ 60,000
Grain grinding and meal storage	8,000
Equipment (pump, valves, distillation columns, etc.)	251,250
Boiler	92,000
Electric	15,000
Erection and piping	68,650
Storage tanks	48,000
Storage bins	7,200
Laboratory	7,000
Contingency (15 percent)	83,000
TOTAL	$640,100

NOTE: Stillage from the batch cooker will be sold in liquid form as opposed to the dried form that results from the continuous cooker process presented. Hardware not required for the batch cooker that was required in the continuous process includes evaporator for stillage, dewaterer and distiller's grain dryer. The batch cooker plant will require three days or 100,000 gallon storage capacity for liquid stillage.

TABLE 3. Continuous Cooker Design--Cost of Production Per Gallon of Ethanol for GAFB Ethanol Plant (Annual Output 1,200,000 gallons)

	$ Cost/Gallon
Feedstock (barley @ $1.65/bushel, including transportation)	$ 0.825
Labor(1)	0.088
Management(2)	0.021
Energy(3)	0.069
Cost of working capital(4)	0.030
Amortizing of 100% loan(5)	0.274
Cost of product	$ 1.307
Sale of dried grains and solubles (7.5 lb/gal @ $0.07/lb)	- 0.525
Net cost	$ 0.782

(1) Six men, 5-day week (3 at $11.05/hr; 3 at $6.25/hr)

(2) Bookkeeper/secretary full time @ $6.25/hr; management ½ time at $12.00/hr.

(3) Energy requirement 43,000 Btu/gallon of gasohol produced. Coal-fired boiler efficiency 75%, $1.00/MMBtu coal and $0.021/gallon for electricity.

(4) Annual interest of 12% on sum equal to expendables, energy, and salary for 3 months.

(5) Loan at 15% annual interest amortized in 10 years.

TABLE 4. Batch Cooker Design--Cost of Production Per Gallon of Ethanol for GAFB Ethanol Plant (Annual Output 480,000 gallons)

	$ Cost/Gallon
Feedstock (barley @ $1.65/bushel including ransportation)	$ 0.825
Labor(1)	0.125
Management(2)	0.038
Energy(3)	0.079
Cost of working capital(4)	0.032
Amortizing of 100% loan(5)	0.260
Cost of product	$ 1.358
Sale of liquid stillage (14 gallons/gallon of alcohol @ $.03/gallon)	- 0.420
Net cost	$ 0.939

(1) Four men, 5-day week; one at $11.25/hr and 3 at $6.25/hr

(2) Bookeeper/secretary half-time at $6.25/hr; management ½ time at $12.00/hr

(3) Energy requirement 50,000 Btu/gallon of gasohol produced; coal-fired boiler efficiency 75%; $1.00/MMBtu for coal and $0.021 Btu/gallon electricity cost

(4) Annual interest 12% on sum equal to expended energy and salary for three months

(5) Loan at 15% annual interest amortized in 10 years.

of 12 percent interest is assumed for this money. The remainder of the costs are self-explanatory, the basis being clear from the description of plant operation.

The monetary value of the distiller's grains and solubles is based on a conservative assessment of the feeding value of this product compared, for example, to bean meal. The value of these protein supplements is almost linearly related to the relative protein content. In Glasgow, soybean meal of 44 percent protein content costs $229.20 per ton from Dawson, Minnesota, the nearest shipping point (minimum of one semi-truck load). On the basis of 28 percent protein content (probably low for barley grains), the value of distiller's grains and solubles would be about (0.28/0.44) X 229.20 =$145.60 per ton.

In confirmation of this, Grain Processing Corporation quoted $130 per ton for distiller's dark grains at Muscatine, Iowa. The Chicago Board of Trade quotation for 44 percent protein soya meal the same day was $197.20 per ton. This would indicate that the equivalence between protein ratio and price ratio is slightly conservative with regard to a distiller's dark grains-soya meal comparison. Thus, the estimated figure of $140 per ton market value is felt to be reasonable. A local feed mill has indicated serious interest in this local supply of protein supplement. Valley County feeders of hogs and cattle have also indicated a willingness to purchase the residues.

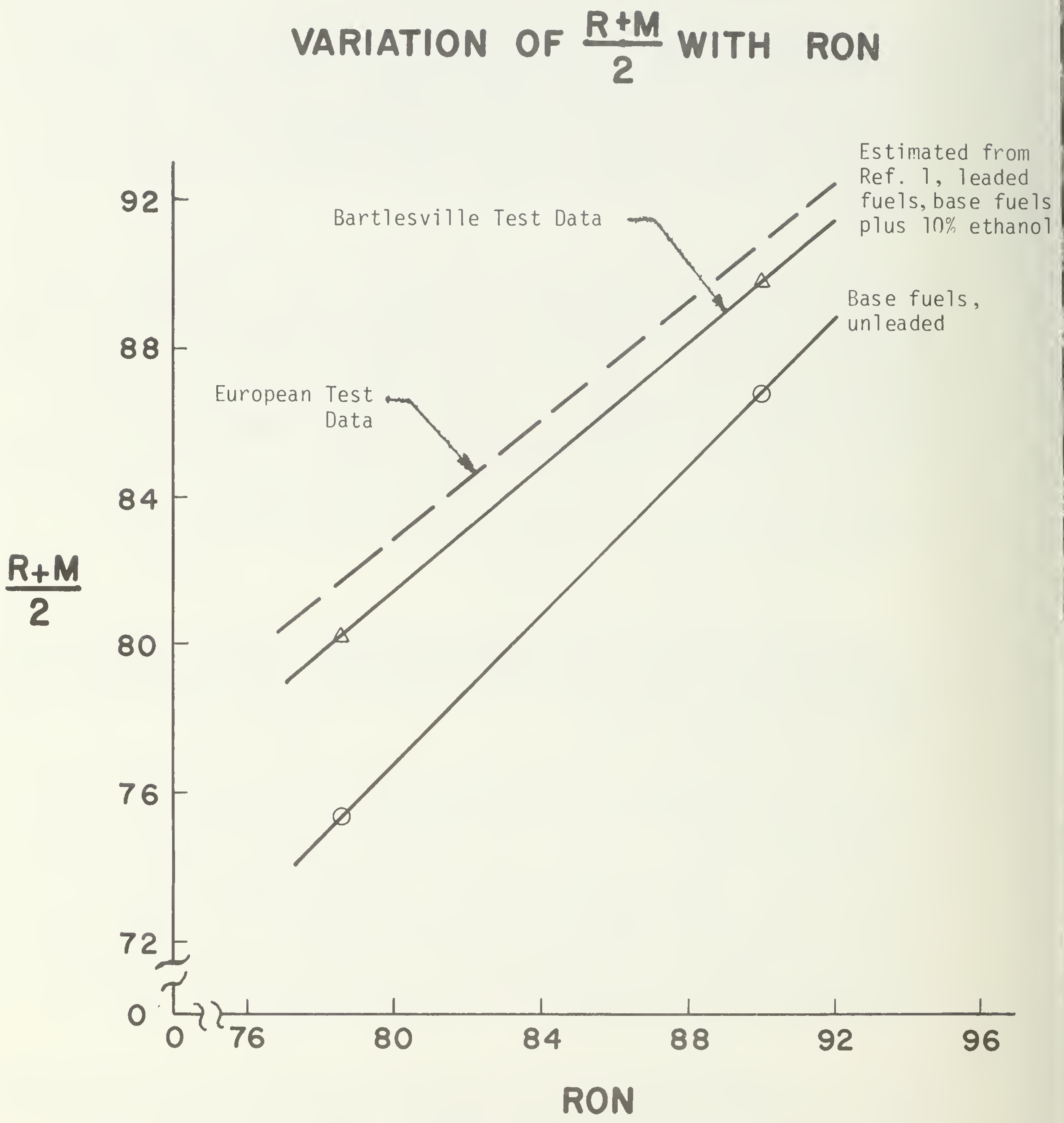
On the basis of this cost of production estimate, it is estimated that the selling price of the alcohol can be about $1.00 per gallon.

Value of Alcohol for Gasohol

The value of alcohol for the production of gasohol is dependent on the value of the gasohol. This is established by the current value of gasoline of equivalent octane number. The octane number to be compared is the average of the Research Octane Number (RON) and the Motor Octane Number (MON), usually represented as (R+M)/2.

Tests have been made at the Bartlesville Energy Technology Center of the DOE to determine the octane response of two unleaded gasolines with the addition of ethanol. The results of these tests for 10 percent ethanol are shown in Figure 6. A dashed line shows the estimated effect of 10 percent ethanol on leaded gasoline based on other test data, principally from Europe. Table 5 shows the octane numbers and f.o.b. prices of gasoline (including the four cents federal tax) from two independent refineries. Also tabulated are estimates of the (R+M)/2 value of these gasolines with 10 percent ethanol and the cost of these blends assuming the price of ethanol to be $1.00 per gallon. The alcohol blends do not include the federal tax since under the energy bill they are exempted from this tax.

It is interesting to note that the near-premium grade fuels using alcohol are significantly less costly than the gasoline of equivalent octane number. This raises the following question: what would be the cost of gasohol having an octane number equivalent to regular gasoline? To estimate this, assume that regular (ethyl) gasoline is purchased without the



Note: RON = Research Octane Number
$\frac{R+M}{2}$ = Mean Value of Research plus Motor Octane Numbers

Figure 6.--Variation of $\frac{R+M}{2}$ with RON

Table 5.--Estimated Octane Number and Price of Ethanol-Gasoline Blend
(Data from two independent refiners)

Refinery	Gasoline	RON[1]	$\frac{R+M}{2}$[2]	Price A[3]	Price B[4]
A	Regular Ethyl	92	88	$0.4975	
	Regular Ethyl + 10% Ethanol		92.5		$0.512
	Unleaded	91.2	87.8	0.5275	
	Unleaded + 10% Ethanol		91		0.539
B	Regular Ethyl	90	86.5	0.4835	
	Regular Ethyl + 10% Ethanol		91		0.499
	Unleaded	90	86.5	0.5110	
	Unleaded + 10% Ethanol		90		0.525
	Premium Ethyl	96.5	92.7	0.5135	
	Regular without Tetra-ethyl lead	85	81.8	0.431	
	Regular minus lead + 10% Ethanol		85.6		0.488

Note: The most important number in comparing octane numbers is $\frac{R+M}{2}$.

[1] RON = Research Octane Number

[2] $\frac{R+M}{2}$ = Mean Value of RON Plus Octane Number

[3] Price A includes 4 cents/gal Federal exise tax

[4] Price B includes alcohol blend

tetra-ethyl lead. The latter costs about 1 1/4 cents for each gallon of regular gas. If we subtract this cost from the price of the regular gasoline, the price of the lead-free gasoline becomes $0.431 per gallon (without federal tax). The value of the RON for this lead-free base stock was estimated as about 85 by the refiner. The cost of gasohol based on this lead-free gasoline would be

$$(0.9 \times 0.431) + (0.1 \times 1.00) = \$0.488 \text{ per gallon.}$$

The value of (R+M)/2 for the gasohol is estimated from Figure 6 to be 85.7, a little low for regular. If we assume 12 percent ethanol, the value of R+M/2 goes up to 86.5 and the cost is

$$(0.88 \times 0.431) + (0.12 \times 1.00) = \$0.50 \text{ per gallon.}$$

This gasohol is unleaded of regular grade. The price of unleaded regular gasoline is $0.511 per gallon. Thus, it is quite probable that the cost of producing gasohol of regular grade with alcohol at $1.00 per gallon will be less than the cost of current unleaded regular gasoline. Thus, the value of alcohol in producing an unleaded, regular grade fuel may be significantly higher than $1.00 per gallon with current gasoline prices.

Since the federal tax exemption is for a five-year period, attention must be given to the question of profitable operation after the present legislation expires. Two favorable factors are operative. First, the cost of crude oil is increasing. It is estimated that the cost of gasoline will increase at least half as rapidly as does the cost of crude. However, perhaps half the cost of production of grain is directly tied to fuel cost. Thus, if crude increases 16 percent in the coming year, gasoline might increase eight percent (+3.8 cents, unleaded regular). The cost of grain would increase four percent (3.2 cents per gallon of alcohol or 0.4 cents per gallon of gasohol). Obviously, the increasing cost of gasoline compared to alcohol, if unchecked, would increase the value of alcohol to the point where the federal tax exemption would be unnecessary. Of course, it is not possible to say how much crude prices will be permitted to increase but almost certainly much more than 16 percent in the next five years.

Second, much work is being done to identify "energy" crops and to conduct field trials of such crops. Such crops have the potential to produce several times the amount of alcohol as does barley or other grains. This will result in significant decreases in the cost of production of alcohol. Also, it should be noted that the plant of this study can increase its output by operating seven days each week. This would reduce the cost of alcohol further.

Employment

Management is assumed to consist of one supervisor at the plant, a half-time bookkeeper-secretary, and half-time attention of one of the members of the corporation. Extra help on Saturday for unloading coal and grain is figured into the delivered cost of the materials. The full-time plant manager will also serve as a laboratory technician. There is one full-time supervisor and one full-time employee for each of the three shifts for the larger plant. The smaller plant has one full-time supervisor during the day shift with three full-time employees working staggered, overlapping shifts.

III.2.4 Legal Requirements

Overview

A grain ethanol production facility will require air and water discharge permits for grain handling, the steam boiler, the treatment of process water, and control of air and water effluents from the ethanol production process, solid waste incineration, and storage of petroleum products. Indoor air emissions, noise levels, and safety conditions must satisfy Occupational Safety and Health regulations.

In addition, fuel produced at this facility must be registered with the Environmental Protection Agency, and cattle feed produced as a by-product must be registered with the Montana Department of Agriculture.

Summary of Applicable Permits and Acts (also see Appendix B)

1. Major Facility Siting Act: Does not apply, unless a large new power supply is required.
2. Air Pollution Permit: Steam boiler, ethanol production process, waste incineration and petroleum product storage will require review.
3. Water Pollution Permit: Steam boiler and ethanol production process will require review.
4. Solid Waste: If incinerated, air permit will be required.
5. Hazardous Waste: None envisioned at this time.
6. Occupational Safety and Health: For indoor noise and emission standards.
7. Water Supply: Water use permit required for expended supply.
8. Power Supply: If new supply is required, see Major Facility Siting Act, and off-site activities may not be applicable to GAFB scenarios.
9. Off-Site Activities: Water diversion construction, pipelines, utility lines, transmission lines.
10. Miscellaneous: Fuel registration.

The applicable laws and permits are detailed in Appendix E (Section 2).

III.2.5 Environmental Impacts

Introduction

The construction and operation of a gasohol/ethanol plant at GAFB should have very little adverse impact on the surrounding natural environment. The use of local grain crops for various plant processes should constitute a highly beneficial use of the existing land and the base facilities. The environmental impacts of this re-use alternative are assessed in the areas of climate and air quality, noise, water quantity and quality, solid waste generation, and land use. These areas are discussed below. Appendix C and Appendix E (Section 4) contain a more detailed discussion.

Climate and Air Quality

An environmental impact on the area's climate may result from the release of water vapor from various plant processes. This could induce local ground fog or surface icing within several hundred feet of the site on cold mornings. Expected sources of air pollution include particulates (small ash-like particles) from the plant's steam generator, gasohol and gasoline vapors, and offensive distillation odors. Wind dispersion, air pollution filters, and proper plant ventilation should prevent these sources of air pollution from becoming adversely impacting.

Water Quantity and Quality

The GAFB water supply system is more than adequate to meet the predicted requirements for pilot plant operation. An expansion of plant activity to about 16,800 gallons per day of alcohol production may require the retrofit of the present delivery capacity to Building No. 945. Small amounts of acids, bases, oxides, and other liquid chemical effluents from the plant's boiler and cooling tower(s) can be controlled by a special (bio-oxidation) handling pond. Accidents involving these effluents could result in the contamination of GAFB groundwater aquifiers and Porcupine Creek. Proper design of the handling pond to accommodate potential flood episodes, together with a properly designed catchment basin at the pond overflow, should satisfactorily mitigate this pollution possibility.

Solid Waste

Approximately one ton of ash per day will result from the coal-fired boiler. Local landfill capacities should be adequate for the disposal of these wastes. No other significant solid wastes will result from the proposed alcohol plant.

Land Use

The impact of these uses on GAFB property and surrounding farmlands should be considered highly beneficial.

Soils

There are no anticipated adverse impacts on GAFB soils. Accidental contamination of soils through the release of effluents from the plant's gasoline and gasohol storage tanks or the holding pond will be highly localized.

Vegetation

At the intended scale of operation, no significant impacts are expected on nearby ranching or cropping operations. Twenty-one hundredths-of an acre of disturbed upland level vegetation including wheatgrass (*Agropyron smithii*) and junegrass (*Koeleria cristata*) will be removed for GAFB site preparation.

Wildlife

Increased railroad, automobile, and truck traffic could result in animal deaths as a result of collisions. Increased hunting pressure resulting from GAFB human population increases may impact game species such as mule deer (Odocoileus heminonus), white-tailed deer (Odocoileus virginianus), sage grouse (Centrocercus urophasianus), and waterfowl species. The impact on these game species will probably not be significantly adverse. The fencing of the GAFB railroad spur line may interfere with the migration patterns of pronghorn (Antipocapra americana). These factors will be less than during previous full operation of USAF activities at the base.

Health and Safety

Workers at the gasohol/ethanol plant may be exposed to leaks in the plant's steam lines, fumes from grain processing and/or gasoline blending and storage, particulate and gaseous emissions, odors, noise from plant machinery, and accidents due to negligence or the improper use of test equipment. Proper plant design will help to reduce or to eliminate these problems, along with protective equipment and worker training.

III.2.6 Social Impacts

The establishment of a gasohol facility at the GAFB should cause little, if any, social disruption. Increased agricultural product use and employment opportunities should provide benefits to Valley County residents. Existing public facilities on the base could experience higher utilization. Details of the social impact assessment are discussed in Appendix C.

Public Acceptance

The response to survey questions concerning a gasohol facility re-use located in Valley County was 69 percent in favor, 24 percent against, and 7 percent unsure. All agencies, organizations, and Indian tribes surveyed supported a gasohol plant re-use for Valley County. No significant negative socioeconomic impact from the construction and operation of a gasohol plant were anticipated by the agencies. The results from the survey are presented in Appendix D.

III.3 Modular Housing Fabrication Center

III.3.1 Introduction

Preliminary suitability and feasibility studies on the use of GAFB as the site for manufacturing energy-efficient modular homes and a building supply materials distribution center were completed. The physical plant at GAFB appears particularly well suited for use as a production facility for manufacturing modular homes. Space is a prime consideration in building modular homes, and GAFB aircraft hangers offer excellent space provisions. Together with installed rail service, abundant storage capabilities for equipment and supplies, existing overhead cranes, and paved out-of-door storage and transfer areas, GAFB supplies the facilities required for modular home production.

The scale of this proposed manufacturing operation is variable. Present housing market conditions in northern Montana and the five-county area surrounding GAFB indicate present and future demand for a minimum production level of five modular homes per week. If housing market conditions for a larger area (including Canada, all of Montana, and the states immediately adjacent to Montana) are considered, a potential market could exist for ten or more modular homes per week.

Additionally, modular townhouses, two-plexes, motels, office buildings, and restaurants can be manufactured on a custom basis using the GAFB facilities. Representatives of various manufacturers also have expressed interest in the suitablility of GAFB facilities for the production of mobile homes. A combined modular home-mobile home manufacturing industrial park appears feasible. Utilizing existing rail facilities for bulk material shipments, the competitive stance for this type of development at the base is greatly improved.

The construction of modular homes in the Glasgow area is not a novel concept, but our analysis of the regional housing market and current product availability indicates that a modular home built to incorporate energy-efficient standards and solar energy options is unique to the area. Estimates we have made based on current data from modular home manufacturers indicate that it is feasible to build quality modular homes. Estimates of modular home construction costs made from data obtained from modular home manufacturers show that a quality home can be built and delivered for under $30 per square foot exclusive of site preparation and land costs.

The idea of including passive solar design features in the modular home construction evolved from an assessment of the current cost of active solar heating systems. The costs of the active solar systems are not competitive with today's fuel prices, hence, it was determined that inclusion of a study for manufacturing active solar systems on the base would not result in a recommended re-use of the base facilities. In the future as fuel prices increase, the active solar systems costs will become competitive with fuel costs, and the modular home business described in this document could expand to include active solar system fabrication.

III.3.2 Fabrication Process Description

Introduction

An overview of the steps involved in the fabrication of a modular home is depicted in Figure 7, and a discussion of the basic steps involved in the construction of a modular home are presented below.

Materials Receiving

A complete list of materials used in the construction of modular homes appears in Appendix E, Section 1. Materials would be received at GAFB by two transportation methods, rail and truck. Bulk materials such as lumber, plywood, gypsum dry wall, roofing materials, etc. could be removed from truck or train using a loader and transferred to the warehouse. Similarly, components such as plumbing fixtures, ranges, windows, doors, etc. could be received and transferred via loader when shipping and packaging allow. Other items could be unloaded by hand and stored as required.

Warehousing

Warehousing consists of materials storage and handling. The area of Building No. 648 is adequate for in-door storage of all necessary materials. Building materials would be inventoried upon their arrival, stored by category and type in various appropriate portions of the warehouse, and distributed as needed to the manufacturing sites and to area building supply retailers and contractors.

Framing and Roofing

The construction of foundations, floor structures, and roofs are separate processes in the building of modular housing. Each component is constructed by separate work crews. The floors are framed with metal herringbone bridging; sub-flooring is constructed with 3/4-inch, 4 by 8 foot C.D. plywood decking. Partitioned walls constructed of 2 by 4 foot studs spaced at 16 inch intervals are added to the completed floor frames using overhead cranes, and ceiling framing then is attached. Roof sheathing (1/2-inch CDX plywood) then is pieced together. Galvanized metal flashing is installed, and asphalt composition roofing tiles are installed over double layer roofing felt. Insulation in the form of aluminum shielded fiberglass is placed in the walls and ceiling. If foam-type insulation is used, it is sprayed after the gypsum board is in place. The completed structure is mounted on rollers and transported to the plumbing and electrical staging area.

Plumbing and Wiring

Upon completion of framing and roofing, all plumbing (pipes and fixtures) is installed. Plumbing is completed in compliance with FHA specifications. Homes are wired for both 110V and 220V AC-type current.

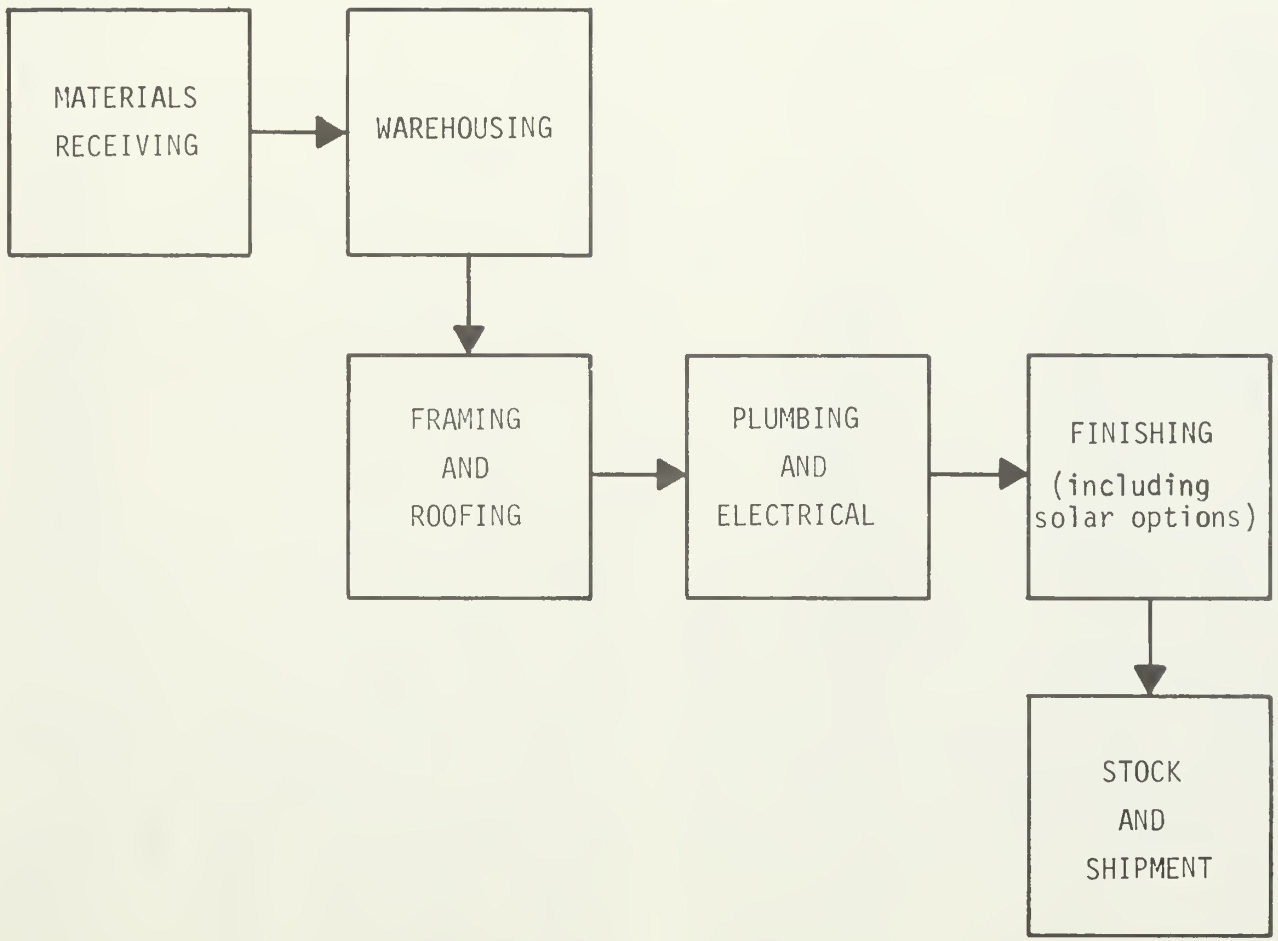


Figure 7.--Modular Housing Process Diagram

Finishing

The finishing process consists of installing gypsum board dry walls, ceilings, flooring and carpeting, exterior siding, interior and exterior doors, ventilating systems, and any special feature(s) requested by the buyer. Interior walls and ceilings as well as exterior surfaces are painted, and galvanized metal gutters and downspouts are installed. Two coats of latex washable paint are applied to interior surfaces, and two coats of exterior latex paint are applied to exterior surfaces.

Stock and Shipment

Finished homes are mounted on transportation carriages and packaged for shipment.

Facility Description

The GAFB facilities are well suited for modular home building. The large open floor space, high overhead clearance, and large doors afforded by the hangers at GAFB are well suited for the requirements of a modular home facility. Minimal construction would be required for framing tables, pressurized air line piping, and storage bins, all located inside the facility. Electrical drops would be installed on building exteriors. Manufacturers estimate that this construction would take less than two weeks and that production could proceed immediately.

III.3.3 Economic Analysis

Introduction

The location of an economically viable entity at GAFB is dependent on matching presently unmet local or regional needs, existing facility capability, and financing and entrepreneurial skill. This process should involve the identification of problems facing Valley County and the adjoining counties which present an opportunity to utilize the facilities at GAFB.

New housing and other construction requirements are an unmet need in the area. The whole state of Montana has a housing need, but rapid growth in selected counties of eastern Montana presents some critical problems. A study funded by the Housing Assistance Office of Action for Eastern Montana (1977) found the following:

> "During the last seven years, eastern Montana has experienced a reversal in the out-migration and population decline of the 1960's and is having to deal with the impact of large-scale mining development and the speculation associated with the investigation of potential new mining endeavors throughout the region. As a result of the population growth in this region and the uncertainty of its future economic climate, the supply of dwelling units has failed to keep up with

> increasing demand for housing. This combination is exacerbated first by the skewed age distribution of existing homes where a large percentage were built prior to 1939 and therefore subject to more rapid deterioration and inhabitability, and secondly by skyrocketing construction costs which make the purchase prices of new dwelling units out of reach of many of the area's residents. The result has been a severe housing shortage in many eastern Montana communities."

Based on this apparent regional need, a potential market appears to exist for moderately priced housing units. This requirement should be considered in the context of the present and future energy shortage and existing regional factors. A moderately priced, energy-efficient housing unit could have a competitive advantage.

Manufactured housing (i.e., commonly called modular housing) exhibits certain economies in construction cost that would lend itself to the production of moderately priced housing units. Certain energy saving techniques such as better insulation and prevention of infiltration already are being incorporated by the industry. Other technologies could possibly be incorporated as options including the following:

1. Solar greenhouses;
2. Entry lock;
3. Enlarged south-facing glass area and enclosed thermal mass;
4. Solar hot water with individual-timed water heaters;
5. Window shutters;
6. Minimum surface exterior walls;
7. Zoned heating;
8. Heat pumps;
9. Sky lights with night shutters;
10. Solar panels;
11. Microcomputer environmental control units; and
12. Off-peak electric energy storage systems.

The above options could be "added-on" features available to the customer either on initial purchase or at a future date when the escalating fossil energy cost would make such additions economically feasible for the individual owner. Incorporating the options in the design would ensure the possibility of retrofit. The important consideration would be to have the base unit designed to allow for these add-on features.

Although the location of GAFB is not ideal for many economic enterprises, the location actually could be beneficial in the case of manufactured housing to supply eastern Montana. Glasgow is the major city between Williston, North Dakota and Havre, Montana. A potential Canadian housing market lies to the north; and a manufactured housing market (currently served by Billings) exists to the south.

Certain of the existing facilities at GAFB could be adapted to house a manufactured housing plant. The establishment of this type of industry could create spin-off industries such as materials distribution to serve the resident plant. The economic importance of a materials distribution center could easily extend beyond a local manufactured housing plant to a regional materials distribution center serving the "high-line" construction industry.

Housing Construction Market Analysis

The market for manufactured housing and other modular-type construction in eastern Montana has both an existing market and a potential near-term market. The market can be analyzed utilizing the following studies:

1. Eastern Montana Housing Inventory, Action for Eastern Montana;
2. MERDI Glasgow Socioeconomic Survey;
3. Analysis of the HUD Public Housing Program in Eastern Montana (Section 8); and
4. Montana Department of Labor Statistics Year-to-Date Construction Permit Authorization.

The following discussion of these four studies is made to clearly show that a sizeable market for housing in the region exists for economically priced, well-built housing. The primary focus of the Action for Eastern Montana report was to document the need for public housing in eastern Montana. Its scope may not be broad enough to fully specify or predict the total housing needs in eastern Montana (i.e., both public and non-public). This is not a reflection on the quality of the report but a note on the limitation of conclusions which can be drawn from that report due to its scope. The prime source data included 1970 and interim census data, Montana state government agencies, local interviews, and utility company records. The existing market for manufactured housing in eastern Montana as identified in the Action for Eastern Montana study specifically identified a need for new homes to be satisfied by the following:

1. Mobile homes;
2. On-site or manufactured housing; and
3. Public housing constructed under the Department of Housing and Urban Development (HUD) Section 8 Program.

This data is used to project the housing needs in eastern Montana by county for the period from 1979 to 1980 as shown in Table 6.

The total of 2,032 estimated potential increase in the number of housing units would result in a potential market for 1,016 homes per year. No definitive assumptions have been made as to how these housing needs are

Table 6.--Projected Demand for Additional Housing Units (1979-1980) in Several Eastern Montana Counties

	1979 Estimate Existing Housing Units In County [1]	1980 Estimate Projected Housing Units In County	Expected Change 1979-1980 In Housing Units
Carter	665	693	28
Custer	5,544	6,194	650
Daniels	1,140	1,145	(5)[2]
Dawson	3,848	3,952	104
Fallon	1,365	1,427	62
Garfield	731	747	16
McCone	896	922	26
Phillips	2,003	2,064	61
Powder River	850	863	13
Prairie	681	712	31
Richland	3,638	3,731	93
Roosevelt	3,515	3,691	176
Rosebud	3,858	4,362	504
Sheridan	1,821	1,792	(29)[2]
Treasure	499	539	40
Valley	4,739	4,945	206
Wilbaux	502	524	22

[1] Estimates based on Action for Eastern Montana study.

[2] Presence of parentheses, ( ), designates an anticipated decline in demand over the period 1979-1980.

to be met, with the exception that customer preference and government action or inaction will greatly influence the eventual mix.

As part of the GAFB re-use project, MERDI conducted an extensive socioeconomic study, primarily based in Valley County. The study consisted of both structured questions and personal interviews. One of the needs perceived by residents of the city of Glasgow is for additional housing units. According to interview results in the rural area, a rural sociological phenomena is in operation whereby a ranch family reaches a certain state where the children either leave the farm to find employment or stay to work the farm. One of the men typically stays and the others are economically forced to migrate to the urban areas. The ranchers express great concern at this and stated that they would like small-scale, non-polluting industrial development at GAFB to ameliorate this situation.

As a by-product of this rural sociological phenomena, the son who remains to work the land typically purchases a mobile home for his new family. The average cost for a mobile home is $21.00 per square foot. According to a local banker, such purchases of mobile homes are not necessarily the result of inherent preference but because the typical ranch cannot afford the cost of on-site construction workers. The cost of this type of construction would be roughly twice the cost per square foot of a mobile home. Additionally, the building season in this area is relatively short. A cost analysis of data supplied by a Montana-based manufactured housing company revealed that units are currently being built for less than $30.00 per square foot; this appears to be highly competitive with mobile homes.

Planners and real estate bankers along the "high-line" also were contacted. The growth and shortage in the housing market, especially in Miles City (which stated 52 percent growth rate in the energy-related developments occurring in the surrounding area), was confirmed by this group. Glendive, on the other hand, is experiencing a temporary housing "glut." It seems that small cities are extremely sensitive to small fluctuations in supply and demand. A regional modular housing manufacturer would not be susceptible to these changes.

Regional energy developments could create very volatile market conditions. For example, large-scale development at Circle, Montana or the Alcan Northern Border Pipeline could create almost instantaneous demands for whole communities. A GAFB location would be beneficial in both situations. When considering a Canadian market, GAFB has the added attractiveness of a high security level and proximity to the Port of Opheim. Due to the security conditions, it would be possible to bring Canadian materials across the line, construct a house utilizing Glasgow labor, and return the finished house to Canada duty free. This would be accomplished by setting up a bonded material warehouse to ensure identity preservation of Canadian materials. This concept is in addition to a free port designation for intrastate warehouses. The whole of Montana is a free port (see 84-3a R.C.M., 1947, U.S. Canada in Section 1 of Appendix E).

This bonded warehouse also could take advantage of favorable tariff agreements of the Canadian government which is beyond the scope of this analysis.

The final unmet regional housing need is Indian housing. This need usually is addressed by HUD public housing programs via bid procedures. The number of units in these bid packages range from 50 to 150. According to a regional architecture firm, program requirement problems exist. HUD has established a cost ceiling of approximately $30.00 per square foot. As in the case of private ranches, on-site construction cannot come close to this ceiling due to transportation costs to the remote sites. While manufactured housing bidders can meet the cost, they cannot concurrently meet the specifications.

The Action for Eastern Montana report concentrated heavily on the need for public housing in eastern Montana and made specific reference to the design criteria for this housing:

1. Eight-plex minimum units;

2. Two bedrooms and 1,000 square feet per unit;

3. A single architectural plan adaptable to different sites; and

4. A manufacture-type construction.

The target price in 1977 dollars was $27.50 per square foot; the report assumed that such construction was not available in Montana but relied on Seattle, Portland, or Salt Lake.

The HUD Section 8 Program in Montana is administered by a statewide housing authority within the Montana Department of Community Affairs (DCA). Under this program, public housing projects from around the state compete for the available housing funds. Although a need exists in eastern Montana, it has not been very successful in this competition for several reasons.

In the first DCA invitation to bid (July 10, 1978), 80 units for lower income, non-elderly families were up for funding. These 80 units were divided into 20 for non-rural land (Billings and Great Falls) and 60 for rural (the remainder of the state). Companies situated in rural eastern Montana did not submit proposals. In the case of rural communities in eastern Montana that requested Section 8 assistance, the construction companies were either from out of state, western Montana cities, or Billings.

Both the location of GAFB and the facility infrastructure could support this market and provide eastern Montana a more competitive bidding posture in relation to Section 8 funding.

The Montana Department of Labor Statistics prepares a state-wide listing of approved building permits. The reports for the years 1977 and 1978 up to July are included in Section 1 of Appendix E. The Department of Labor representatives feel that around 80 percent of listed permits actually enter construction. Additionally, not all construction (especially rural buildings) obtain building permits. This listing tends to confirm projections made by the Action for Eastern Montana report.

Modular Home Cost Analysis

The initial investment required to initiate an operation that can produce at this level is approximately $40,000. The capital costs consist of the following elements:

1.	Factory machinery, jigs and equipment	$20,000
2.	Office equipment	10,000
3.	Lease hold improvements	10,000
	TOTAL	$40,000

Of particular importance is the investment in factory machinery and tools. A listing of typical equipment is included in Section 1 of Appendix E. These costs establish the operational costs.

Additional cost factors are the monthly rental, the cost per mile to transport a typical two-piece unit, and the dealer mark-up. The factory rental cost is $500 per month. This is prorated at $125 per house at four houses per month at the existing modular housing manufacture plant. Since this cost will be different at GAFB, it is eliminated in the following analysis. The cost to transport a modular house in two pieces is $4.00 per mile, provided the necessary equipment is owned by the modular home manufacturer. Most dealers combine the house cost with the lot and lot preparation costs. As an estimate, the manufacturer believes that normal mark-up on his house is around 10 percent.

As an estimate, the cost to produce a house at GAFB could range from $27.39 to $29.79 based on the following calculations:

1. Estimated average cost per square foot excluding factory rental;
2. Rental cost at GAFB;
3. Transportation cost at worst case; and
4. Dealer profit and estimated total cost per square foot.

Typical Cost Per Square Foot Exfactory Excluding Attributable Factory Rental Cost

A sample of typical house plans based on square footage was arbitrarily selected. In each case, the most expensive option was selected. The exfactory costs were reduced by the rental cost per unit of $125. The sum of the exfactory cost excluding factory rental was divided by the total square footage to determine an unweighted average cost per square foot exfactory and excluding rental as follows:

	Square Feet	Exfactory Cost Including Rent	Rent Per Unit	Excluding Rent
	864	$21,270	$125	$ 21,145
	950	21,610	125	21,485
	1,000	22,250	125	22,125
	1,200	26,400	125	26,275
	1,400	30,240	125	30,115
TOTAL	5,414			$121,145

Estimated Average Cost per Square Foot: $\frac{\$121,145}{5,414 \text{ ft}^2} = \$22.38$

Rental Cost at Glasgow AFB

The estimation of rental costs is based on Hanger No. 648. Although this facility contains 27,800 square feet of space, only 20,000 square feet are useable. Of this figure, only 4,000 square feet are required to build four houses a month, assuming that only two are produced at the same time. The rental of this facility is $1.60 per square foot per year or 13 cents per square foot per month. Therefore, the rental cost could be either $520 per month (i.e., 13¢ x 4,000 square feet) or $2600 per month (i.e., 13¢ x 20,000 square feet) depending on whether a portion or the whole facility was rented. Assuming an average house size of 1,000 square feet, these figures would be from 13 cents to 65 cents per square foot.

Transportation Cost at Worst Case

The transportation cost for a two-section modular home is approximately $4.00 per mile. Assuming a worst case range of 500 miles, this would be $2,000, and assuming that an average house contained 1,000 square feet, this would be $2.00 per square foot.

Dealer Profit and Estimated Total Cost per Square Foot

The dealers profit has been assumed to be 10 percent. The total cost per square foot then would range from $22.51 to $23.03 depending on the rented cost per Hanger No. 648 developed as follows:

With factory rental cost at 52 cents per square foot

Average cost per square foot excluding factory rental	$ 22.38
Factory rental	.13
Transportation cost, worst case	2.00
SUBTOTAL	$ 24.51
Dealer mark-up at 10 percent	2.45
TOTAL	$ 26.96

The above figures are very close to target costs.

With factory rental cost at $2.60 per square foot

Average cost per square foot excluding factory rental	$ 22.38
Factory rental	.65
Transportation cost worst case	2.00
SUBTOTAL	$ 25.03
Dealer mark-up at 10 percent	2.50
TOTAL	$ 27.53

Solar Option Cost Analysis

This discussion is provided as a first-order analysis of the cost of implementing a solar option in the design of a modular home and the potential space heating cost savings that could result from such a feature.

One of the options that could be incorporated into the modular home design is passive solar gain and heat storage. The proposed option would not provide 100 percent of the space heating requirements in a residence but could potentially supplement the space heating demand by as much as 50 percent. This amount of space heating savings could prove to be very attractive to many eastern Montana residents who are situated in areas where natural gas is not available and who must rely on expensive electric and propane heat.

In our analysis, we estimated that an option to construct a house with enough south-facing glass and heat storage (fiberglass containers filled with water) and nighttime insulation to provide about 50 percent of the space heating load of a house could cost approximately $3 per square foot extra for a 1,200 square foot house. See Section 1 of Appendix E for analysis details.

If the "typical" residence considered in this analysis had an annual space heating bill of $598, the yearly savings due to passive solar heating would be $299. To determine the dollar savings for subsequent years, the space heating costs will be inflated at a rate of 6 percent annually. (This rate of increase for the electric costs is modest compared to that projected in a Montana Power Company report to the Public Service Commission, June 1978.) At this rate of increase, the second year's savings would be $317, the fifth year's savings would be $371, the tenth year's savings would be $505, the twentieth year's annual savings would be $853, etc. While the dollar savings in energy costs increase each year, the payment on this loan made at the time of the house purchase remains constant. For example, if the solar option mentioned above cost $3 per square foot, the initial add-on cost to the basic house price for a 1,200 square foot house would be $3,600. Assuming that the resident purchased a house on a 30-year mortgage and the annual interest rate was 10 percent, the $3,600 solar option would add $377 per year to the house payment. Comparing this cost to the annual energy savings, we can see that there is a net loss to the resident until the fifth year. Table 7 shows a summary of estimated annual space heat savings and annual added costs to the mortgage payments of the proposed solar option. From this table, one can see that, over the life of the loan, substantial savings result. Also shown in this table is a cumulative net savings column. From this column, we can see that the initial $3,600 can be paid back after about 20 years.

This analysis was not provided to give the actual savings one might expect to obatin. Rather, it was to demonstrate that solar options added at the time of house construction and initial purchase can result in deferred payments in the home mortgage that will remain constant as fuel prices increase. This approach provides a unique and viable marketing tool for a potential manufacturer.

The incorporation of such unique features at the conception of establishing a modular home fabrication facility is desirable from the standpoint of determining designs, building jigging, purchasing materials, and planning assembly procedures. The necessary equipment and procedures for this option could be incorporated into the design of a new facility easier and more economically than incorporating them into an established facility.

Scale of Operation

The extent of impact that the modular home manufacturing operation would have on the environment and employment would depend upon the scale of operation, and the scale of operation would be dependent upon the demand in the market for modular or mobile homes and buildings that might be manufactured at the facility. The actual demand would depend upon many factors

Table 7.--Projected Annual Capital Costs and Annual Space Heating Savings for Passive Solar Heated Home

Year of Payment	Annual Cost of Added Solar Option[1]	Annual Savings for Space Heating Costs Due to Added Solar Option[2]	Annual Net Savings in Heating Costs Due to Added Solar Option	Cumulative Net Savings in Annual Space Heating Costs
1	377	299	-78	-78
2	377	317	-60	-138
3	377	336	-41	-179
4	377	356	-21	-200
5	377	371	-6	-206
6	377	400	23	-183
7	377	424	47	-136
8	377	449	72	-64
9	377	476	99	35
10	377	505	128	163
11	377	535	158	321
12	377	567	190	511
13	377	601	224	735
14	377	637	260	995
15	377	675	298	1,293
16	377	716	339	1,632
17	377	759	382	2,014
18	377	805	428	2,442
19	377	853	476	2,918
20	377	904	527	3,445
21	377	958	581	4,026
22	377	1,015	638	4,664
23	377	1,076	699	5,363
24	377	1,140	763	6,126
25	377	1,208	831	6,957
26	377	1,280	903	7,860
27	377	1,357	980	8,840
28	377	1,438	1,061	9,901
29	377	1,524	1,147	11,048
30	377	1,615	1,238	12,286

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[1] Passive solar option at $3 per square foot for 1,200 square foot house adds $3,600 to initial house costs. Ten percent interest rate on a 30-year loan used for calculating annual costs.

[2] A 50 percent contribution of passive solar heating option assumed. Initial annual space heating bill of $598 used. Space heating costs were inflated at 6 percent per year.

that cannot be accurately determined; therefore, by considering the potential market, three levels of manufacture were assumed for the purpose of analysis.

1. Low Production Scenario--The low production scenario consists of the manufacture, sale, and distribution of five modular homes per week. The use of one building and the existing transportation network (roads and railways) would be required.

2. Middle Production Scenario--The middle production scenario consists of construction of up to ten modular homes per week in addition to increased stocking of building materials and subsequent creation of a wholesale building materials distribution center. Component structures such as walls, floors, roof trusses, etc. also would be manufactured for sale and shipment throughout the Pacific Northwest.

3. High Production Scenario--Potential exists for a four-phase home building industry at GAFB. This includes 1) production of modular homes (10 per week), 2) production of component structures (as demanded by market conditions), 3) wholesale distribution center for building supplies, and 4) production of mobile homes (500 per year). This scenario would require four buildings and possible maintenance facilities for tractor trailors used in shipping. In addition to the operations and facilities identified in the middle production scenario, a fourth building would house the mobile home manufacturing.

Employment

An estimate of the employment for the three levels of production proposed are given below.

> At a production level of five modular homes per week, manufacturers estimate that 30 to 40 persons would be employed. The bulk of the employees would be unskilled (17 to 22), with skilled labor in the form of carpenters, electricians, and masons (7 to 12), the next largest group. A sales and management staff of 5 to 6 employees would be required for this scope of operation.
>
> For the middle production levels indicated above, an integrated facility producing modular homes and component structures and serving as a wholesale distribution center for building materials would employ approximately 170 persons based on manufacturers' estimates. Management sales would consist of 20 employees, skilled labor approximately 50 employees, and unskilled labor approximately 100 employees.
>
> The high production scenario would result in the following employment level. Manufacturers estimate upward to 400 employees would be necessary to operate a facility at the high production level. Unskilled labor would approach 250 employees, skilled labor approximately 100 employees, and management and sales would account for 50 employees.

III.3.4 Legal Requirements

Overview

There appears to be no requirement for an air pollution permit, unless solid waste is incinerated on site. Paint residuals, wood particulates, etc. will necessitate pretreatment of wastewater before discharge into public sewage systems. Occupational safety and health standards within the facility will have to be satisfied with respect to noise, paint fumes, sawdust, and other emissions.

The finished product must satisfy state building code standards and must receive an inspection insignia from the Department of Administration.

Summary of Applicable Permits and Acts (also see Appendix B)

1. Major Facility Siting Act: Does not apply.
2. Air Pollution Permits: None required, unless solid waste is incinerated.
3. Water Pollution Permits: Paint residuals, wood particulates, etc. may necessitate pretreatment before discharge into sewer.
4. Solid Waste: Large volumes of inert waste (packing materials, scraps, etc.) must be either incinerated or disposed of at a landfill. Note: Inert wastes may be disposed of at Class III sites; safequards against leaching and water pollution not required.
5. Hazardous Waste Permits: Do not apply.
6. Occupational Safety and Health: For noise and indoor emission standards (e.g., paint fumes, sawdust, etc.).
7. Water Supply: Existing supply is adequate.
8. Power Supply: Existing supply is adequate.
9. Off-Site Activities: Do not apply.
10. Miscellaneous: Housing units must satisfy state building codes.

The laws and permits which are applicable to this alternative re-use are detailed in Appendix E (Section 2).

III.3.5 Potential Environmental Impacts

Introduction

The implementation of any of the modular housing production scenarios should result in virtually no adverse impacts to GAFB and the surrounding county's natural environment. The following subjects which were considered in the environmental assessment are summarized in the following sections: climate and air quality, noise, water quality and quantity, solid waste generation, land use, soils, vegetation, wildlife, and health and safety. Further discussion on these areas can be found in Appendix C.

Climate and Air Quality

No adverse or beneficial impact is projected for GAFB climate even if the high production scenario is implemented. Increased railroad, automobile, and truck traffic in the area could result in increased, although legally tolerable, gaseous and particulate emissions at all three production levels.

Noise

The use of power tools during both the construction and operation of the center may result in noise levels approaching 80 dBa within about 50 feet of the source. Workers may be required to wear protective ear plugs. The overall noise levels outside the fabrication sites should be negligible.

Water Quantity and Quality

The present water delivery services at GAFB will be adequate to meet the demand of all production scenarios. Effluent discharge primarily composed of paint residuals and domestic sewage will be handled adequately by minor pretreatment prior to disposal in the existing sewage system and treatment facility.

Solid Waste

Packaging materials such as lumber, cardboard, styrofoam, metal banding and paper, and wood stud, metal and other fabrication scraps will be produced during the retrofit of GAFB buildings and the fabrication of modular housing. The disposal of these wastes may become adversely impacting with the implementation of the middle and high production scenarios. The use of these wastes by local residents and waste disposal in local landfills should mitigate potential problems.

Land Use

Existing GAFB buildings will be utilized in the implementation of all three production scenarios. The impact of the use of GAFB property for this re-use should be considered highly beneficial.

Soils

No significant impacts are expected during factory set up or production.

Vegetation

No significant adverse impacts are anticipated with this re-use. Any impacts will be highly localized and of short-term duration.

Wildlife

Increased railroad, automobile, and truck traffic could result in animal deaths as a result of collisions. Increased hunting pressure resulting from GAFB human population increases may impact game species such as mule deer (*Odocoileus heminonus*), white-tailed deer (*Odocoileus virginianus*), sage grouse (*Centrocercus urophasianus*), sharp-tailed grouse (*Pedioecetes phasianellus*), and waterfowl species. The impact on these game species will probably not be significantly adverse. The fencing of the GAFB railroad spur line may interfere with the migration patterns of pronghorn antelope (*Antipocapra americana*). These impacts are much less than occurred when the base was in operation.

Health and Safety

The facility will be constructed and operated to meet all federal, state, and local worker health and safety requirements. Protective equipment and forced draft ventilation in noisy, dusty, or hazardous areas should mitigate any adverse impacts.

III.3.6 Social Impacts

The implementation of the modular solar housing production scenarios should have no significant negative social or economic impacts. The increase in employment opportunities would help to diversify the economy based primarily on the agricultural sector. Excess housing and unused educational, medical, and public service facilities at the Glasgow Air Force Base could again be utilized. The potential social impacts from this alternative are discussed in detail in Appendix C.

Public Acceptance

The response to survey questions concerning modular solar home manufacturing re-use located in Valley County was 82 percent in favor, 7 percent against, and 11 percent unsure. No major negative socioeconomic impacts were anticipated by the agencies, organizations, or tribes surveyed, and all elements approved of the modular solar home manufacturing re-use. Appendix D details the results of the attitudinal survey.

III.4 RAIL CAR REPAIR FACILITY

III.4.1 Introduction

Glasgow AFB is located approximately 18 miles from a main east-west Burlington Northern (BN) railroad line. This route is a major thoroughfare for goods being transported between the midwest and the west coast. BN stated that 24 to 26 million ton miles of commodities were transported during 1978 on its section of this east-west route. This represents railroad car traffic of over 600,000 cars annually. The cars that travel this route are comprised of BN cars, foreign cars (non-BN cars owned by other railroad companies), and privately owned railroad cars. The private cars are owned by large companies and railroad car leasing firms. This main rail line is connected to the GAFB facilities with a spur line that is suitable for light-to-medium duty rail traffic.

One suggested re-use of GAFB facilities has been as a railroad car repair facility. Some justification for this potential re-use includes

1. The close proximity and large amount of rail traffic on the BN line;
2. An existing rail spur from the main track to the base;
3. The availability of large buildings (aircraft hangers) on the base that are well suited for conversion to rail car repair shops;
4. The lack of other rail car repair facilities in the area to service foreign line and privately owned cars;
5. The potential for increased rail car use activities in eastern Montana resulting from increased demand for coal throughout the country; and
6. A rail car repair facility would be both environmentally compatible with the area and socially acceptable to the community.

In addition, the Montana International Trade Commission (MITC) has expressed a general interest in developing additional rail car facilities in Montana with emphasis on GAFB as a potential site. The facility proposed by MITC would involve the manufacture and repair of rail cars with particular attention being placed on building coal-carrying cars to meet the anticipated increased demand for such cars as coal mining and exporting progresses in eastern Montana.

Although placement of a railroad car repair facility at GAFB has some apparent merit, it is not without problems. Essentially, these problems lie in the ability of the repair facility to attract a sufficient volume of buiness to meet capital and operating expenses. The nature of this problem will be presented in the following discussions. The main reasons for the potential difficulties lie in the fact that the proposed repair facility is not located on the main line (it is about 18 miles from it) and the Glasgow area is not currently a major pick-up or delivery area for commodities.

The intent of the discussion on this potential re-use of GAFB facilities is to provide an explanation of the steps involved in the operation of a repair facility, to describe the physical make-up of a proposed facility, and to outline the economic conditions that must be met to warrant an in-depth development of undertaking the proposed option.

In this context, two different approaches for establishing a rail car repair facility at GAFB are taken. First, a facility of moderate size that might have the potential to provide repair services to the existing traffic on the main railine is discussed. Secondly, a much larger facility that would provide repair and preventative maintenance services for a future fleet of coal cars is proposed. These two schemes are outlined, and only an in-depth analysis at the investor level will enable one to determine the feasibility of the approaches suggested. Justification for the first approach was discussed above, while the following argument lays the groundwork for pursuing the second approach.

Montana has experienced rapid growth in coal development. The destination of Montana coal that was produced in 1973 through 1976 is shown in Table 8. Various scenarios for the growth of western coal development have been prepared by MERDI and other research organizations. MERDI's projections for coal-fired additions and western coal use through 1990 are given in Table 9.

Although there are differences in the growth estimates, all researchers share a concensus that growth will continue at a rapid rate. According to BN estimates, transported coal will increase from 60 million tons in 1978 to between 115 and 140 million tons in 1982. During that period, BN expects to make capital expenditures of $2.1 billion of which approximately one half will be coal related. As a method of conserving capital funds, BN has encouraged the coal-burning utilities to purchase their own rail cars.

Presently, the coal being mined is shipped by rail car. This transport of coal has become BN's largest single source of rail transportation revenue. Approximately 83 percent of the coal traffic by BN in 1977 originating in Montana and Wyoming was destined for the midwest, the Great Plains, and the southwest. The majority of this coal was mined in the Fort Union Basin, in an area extending approximately from Douglas, Wyoming to Forsyth, Montana (i.e., southeastern Montana).

In 1977, approximately 93 percent of this coal production was shipped in unit trains. A unit train consists of 100 or more cars, each

Table 8.--Coal Shipments from Montana to Electric Utilities--1973-76[1]
(Million tons)

Region	1973	1974	1975	1976
Minnesota	3.92	5.23	6.21	8.16
Wisconsin/Michigan	.13(3)	.99	3.22	4.13
Illinois/Indiana	5.66	6.68	10.13	10.12
Midwest/Southwest	.04(3)	.21(3)	.63(3)	.23
Pacific Northwest	0.00	0.00	0.00	0.00
Montana	.88	.82	1.20	2.32
Total Utility Shipments	10.62	13.94	21.38	24.96
Total Montana Production(2)	10.73	14.12	22.16	26.18

(1) Source: Federal Power Commission, Form 423 Reports

(2) Source: Montana Department of Revenue

(3) Primarily Spot Purchases

Table 9.--Proposed Coal-Fired Additions and Western Coal Use--1980-90[1]
(Thousand megawatts)

Region	Proposed Coal Fired Additions			Additions Planning Montana Coal Use			Additions Planning Wyoming Coal Use			Additions Planning Unspecified Western Coal		
	1980	1985	1990	1980	1985	1990	1980	1985	1990	1980	1985	1990
1. Minnesota	.7	2.9	3.2	.7	2.1	0.0	0.0	0.0	0.0	0.0	.8	3.2
2. Michigan/Wisconsin	1.0	5.1	4.2	0.0	1.4	0.0	.9	1.2	0.0	0.0	1.4	.7
3. Illinois/Indiana	5.7	8.2	9.7	0.0	0.0	0.0	1.5	2.6	0.0	0.0	0.0	0.0
4. Midwest (excluding Texas)	9.4	15.4	5.6	0.0	0.0	0.0	7.4	8.6	2.8	0.0	1.3	.2
5. Pacific Northwest	0.0	.3	(1.4)(2)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	.3	(1.4)(2)

(1) Source: G. Kuntz, Final Report to Montana Energy Model Project, Table XI, January 1978.

(2) May be proposed if nuclear unit not built.

capable of carrying 100 tons and pulled by three to seven 3,000 horsepower locomotive units. The unit train carries only one type of commodity and usually operates exclusively between two established points. The advantages of a unit train (Polzin 1977) are listed below:

1. Cars are less likely to be diverted to other uses in times of emergency or extreme car shortages;
2. The mine is assured of being able to load cars previously loaded with coal, thereby minimizing the need for cleaning;
3. Cars can be designed for this specific service; and
4. Ownership of the cars can be a factor in negotiating long-term contracts. That is, freight rates may be lower when the coal is shipped in cars owned or leased by a party other than the railroad.

While this increased coal mining and railroad activity is interesting, several very important factors must be kept in mind when considering a rail car repair facility at GAFB:

1. The coal being mined is a subbituminous coal located in the southeastern part of the state;
2. The markets for the coal are east, south, and west of the mines;
3. BN has rail car repair facilities located at Laurel, Montana and Havre, Montana;
4. A private rail car repair facility is being planned for Glendive, Montana, and GAFB is approximately 200 rail miles from Glendive in the opposite direction of the coal markets;
5. The known resources of subbituminous coal are sufficient for another 50 years of supply, and the only known coal reserves near GAFB are low-Btu, lignite coals which are currently not considered economical to ship to distant markets.

Although this last statement points out that the lignite coals found in the GAFB vicinity are currently not economically attractive for export outside of the state, this coal might become a viable export in the future. If Montanans refuse to allow the lignite coals to be burned or processed at mine mouth facilities, they will be forced to haul this coal from the area. Also, if the demand and, hence, the cost for exported coal increases past either the mineable output or reserves of subbituminous coals, then lignite coal value will increase in value and potentially become an exportable commodity.

III.4.2 REPAIR PROCEDURES AND FACILITY DESCRIPTION

Introduction

As mentioned in the above discussion, re-use of GAFB facilities was approached from two different perspectives. Essentially, the approaches vary only in scale. First, a facility is proposed to service the existing traffic and will be designed to perform a limited amount of repair functions. Secondly, facility operations proposed to service a potential coal train market that might exist in the future will be much larger and will be sized and equipped to handle large numbers of rail cars. The large facility would be equipped to service unit trains through a preventative maintenance procedure and to perform minor repair functions in a matter of a couple of days. The operation procedures for each type of facility are briefly discussed in this section of the report. First, though, an outline of the types of repairs that rail cars currently undergo and the time and equipment needed to perform them will be discussed.

A detailed listing of the procedures involved, time required, and equipment necessary to perform rail car repair and maintenance services can be found in the Association of American Railroad's (AAR) Interchange Rules Field and Office Manuels (AAR 1977). These manuals are the text by which all repair facilities, both privately and railroad owned must operate.

A survey of the Field Manual of the AAR Interchange Rules plus visits to the BN shops at Laurel and the BA&P shops at Anaconda provide a good overall view of the kinds of operations expected at a contract repair shop.

The major subsystems of a rail car are as follows.

Body

- Includes all gear for specialized carriage of specific commodities
- Sills, center, and side (frame members)
- Running board, dome platforms, brake steps, crossover platforms, grab irons
- Body bolsters
- Cushioned underframe devices

Brakes

- Cylinder assemblies
- Valve assemblies
- Piping and hoses
- Brake beams, hangers, rods
- Brake shoes
- Hand brakes

Trucks

- Wheels
- Axles
- Journals: boxes, bearings, associated parts
- Springs, assemblies
- Sideframes
- Track

Coupler Assemblies

- Couplers
- Draft gear
- Yokes

Each of the items and assemblies has its own set of maintenance standards and requirements and must be maintained in conformance with AAR and/or federal standards. Some parts are intended to wear out, including coupler knuckles, wheels, brake shoes, and wearplates on trucks and brakes. On some classes of cars, particularly hopper cars for ore, coal, and similar materials, specific body parts are expected to wear.

Repair of cars is intended to identify and renew those wearing parts on trucks, couplers, and brakes and to repair those failed parts which are necessary to restore the car to safe and economical use. Rebuilding is intended to produce a car in new condition; a car to be rebuilt is essentially disassembled into its component parts and reassembled, replacing (and occasionally repairing) all parts that have failed or show evidence of future failure.

For purposes of discussion in this document, rail car repairs will be grouped into categories that are defined by the nature of the repair or maintenance item and man-hours needed to complete that item. These classifications and criteria generally follow those used by BN at its repair facilities.

One class of repairs is termed as running and minor repairs. These repairs require less than 20 man-hours per car and often take only about four to five man-hours per car to complete. A second class of repairs is termed as heavy repairs and typically requires 20 to 80 man-hours for various types of heavy repairs, including replacement of major components such as trucks, wheels, brakes, couplers, etc. A third class of repairs is called major repairs and includes significant car refurbishing due to excessive wear or wrecks. This class would also include major overhaul of rail car components that require many man-hours and special equipment. Typically, major repairs are considered those that require an excess of 80 man-hours per car.

BN has a repair facility at Laurel, Montana where most of the heavy repairs on its cars are completed. The Laurel repair shop repairs only BN cars and does not have excess capacity for other companies' cars.

The shop handles a very high volume of business and encompasses both the repair and preventative maintenance aspects of rail car servicing. Major repairs, (i.e., those estimated to require more than 80 man-hours of work) are not handled at the Laurel facility. The cars that require major work are sent to a BN facility at Alliance, Nebraska. The reason for this is that the railroad company must process the cars at a high rate to keep the volume of available rolling stock up. Cars that are temporarily out-of-service for minor repair and/or maintenance cost the company revenue. Hence, the Laurel facility is designed and staffed to process a large number of cars that need only minor and heavy repair and maintenance. The scale of operation at Laurel is similar to what would be required to handle large amounts of coal car traffic if the lignite coals in the vicinity of GAFB were to be mined and exported. To make a business of this scale profitable at GAFB, large numbers of cars would have to be processed annually.

BN operates a rail car repair facility at Havre, Montana. This facility is located on the same east-west track as Glasgow. The Havre repair facility services both locomotives and rail cars. The rail car repair operations at Havre are generally for running and light repairs and maintenance work with a limited amount of heavy repair work being completed. Light and running repair and maintenance are performed on about 40 cars per day and only about four or five heavy maintenance jobs are performed per week. No major work is performed on rail cars. This facility handles all of the running and minor maintenance for BN railcars on this northern east-west route. An operation on the scale of this facility is what is proposed for possible implementation at GAFB to use in attracting any current rail car repair market that might exist along the line. The type of repair work would be limited to heavy repair. Discussion on why these types of repairs were chosen over others is provided later.

Facility Description--Current Rail Car Repair Market

A rail car repair operation at GAFB designed to service the current rail traffic along the BN line should be configured to perform heavy repairs. The reason for this is that running and minor repair and maintenance generally require less than 20 man-hours to perform and often only require four to five man-hours. If a car must be moved along the 18 miles of track from the main line to the facility, the additional transport time would be too large a portion of the total repair time; hence, the car turnover rate would be significantly impacted, and the number of cars that need to be handled would be high. On the other hand, a maintenance facility designed to make major repairs would need added expensive machinery and tooling that would not be needed by a less sophisticated repair station. Hence, the capital requirement for a repair station equipped to do major repairs would be greater than that required for heavy repairs and overhauls. The advantage of having a smaller capital requirement for tooling and machinery is that the total workload can be less to cover expenses. Also, the less capital invested into an operation for machinery and tooling makes the existing capital at Glasgow (the buildings and utilities) a larger portion of the total capital needed to initiate an operation.

A rail car repair facility designed to accommodate the existing private and possibly some foreign line traffic would be sized according to the expected traffic and type of repair and maintenance work that would be undertaken. The factor determining the potential size of the rail car repair facility would be the expected market for such services and not the facilities available at Glasgow. The facilities at GAFB are large enough to accommodate quite a large rail car repair operation. For example, one of the single 110 by 250 foot hangers at the base could easily house a two-track, four-bay repair facility with support material and equipment, storage, machine area, office space, etc. to process two cars per day for a single shift operation. This rate of repair is made assuming that the cars processed are in the heavy repair category with an average repair time of about 60 man-hours and a four-man crew at each bay. The size of the repair operation would be suitable for processing about 500 cars annually.

Listed below are some of the major items that would be required at such a facility if it were placed at GAFB.

1. Trackage and Switching--Approximately 7,000 feet of track would be needed. Rails for storing bad order and repaired cars would be required in addition to trackage and switching for moving cars around the repair area and through the hangers.

2. Equipment--The following is a partial list of some of the major equipment needed for a heavy repair facility.

   a. 75 and 150 ton capacity jacks for lifting loaded cars;
   b. 50 ton capacity overhead crane;
   c. 5 and 2.5 ton capacity jib cranes;
   d. fork lifts;
   e. coupler cart and equipment;
   f. brake test cart and equipment;
   g. draft gear removal tools and installation cart;
   h. verhead swing assembly to mount power, air, water, welding, grease, etc. and connections;
   i. other special equipment and hand tools; and
   j. benches, cabinets, storage bins, etc.

3. Yard Locomotive--One 600 horsepower locomotive to move cars between the main track and repair facility.

Another factor to recognize in determining the feasibility of a proposed facility is that the repairs that fall under the heavy repair and maintenance category are regulated in accordance with the Association of American Railroad's (AAR) rules. These rules allocate man-hours for each function performed and, hence, regulate the costs that are charged for specific services. On the other hand, major repairs such as repair of wrecked cars and excessively worn cars are not regulated, and the potential profit margin is greater. Hence, another option that could be excercised in the operation of a major repair facility would be to purchase high-repair-hour cars, rebuild them, and then resell them to railroad companies or private companies. Using this method allows a flexible profit margin since the sale and resale prices of used cars are not regulated by AAR rules. Such a scheme, though, would require additional capital to carry the costs of the rail stock on hand and would require a significant increase in the amount of repair equipment and facilities needed to conduct the work.

Facility Description--Future Coal Car Market

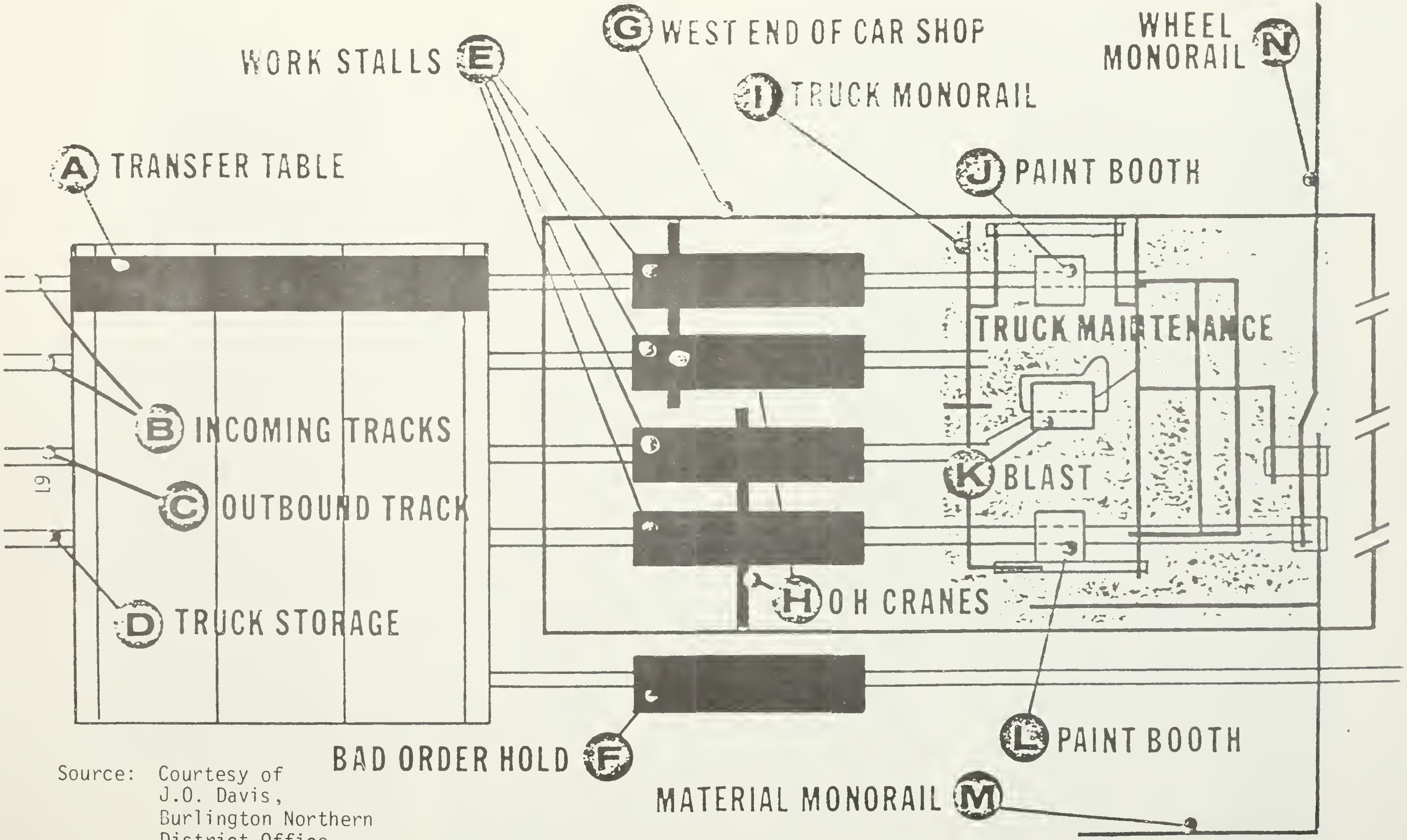
A repair facility designed to handle large numbers of rail cars that might result from the transport of lignite coals from northeastern Montana would have to be a large highly automated facility to be able to service unit trains on a quick turnaround basis. The high volume, low cost transport of coal that results because of the unit train concept is mainly due to the fact that the coal cars are almost continuously on the move and have little or no dead time. Hence, any scheme proposed to service or repair these cars must be compatible with this concept.

For normal utilization cars, the railroad companies have generally taken a policy that does not incorporate a preventative maintenance program. In the past where rail cars typically accumulated 25,000 miles or less each year, this procedure has been satisfactory. With the unit train concept, rail cars can routinely accumulate 175,000 miles annually making this procedure no longer satisfactory. These cars are generally built for high utilization service and are required to undergo preventative maintenance servicing to insure that they are in good repair continuously.

The preventative maintenance program involves the routine check out and replacement of certain components on a regular basis. Since it is important to keep these high utilization cars in service, the shops that perform these preventive maintenance operations are usually highly automated and employ a large work force. An excellent example of such a facility is the one at Laurel, Montana. If the facilities at GAFB were to be utilized for repair and maintenance of unit cars, it would be necessary to build a facility similar to that at Laurel. A schematic diagram of the Laurel facility is shown on Figure 8. The rail cars to be repaired are fed to the transfer table on incoming tracks. The electrically operated table then transfers the car to a work stall where the various repairs are undertaken. After the car is repaired, it is moved back onto the transfer table for placement on an outgoing track.

A step-by-step description of the Laurel rail car repair shop process follows:

> Step 1--Unit train coal cars are brought from the marshalling/feeder yard to an inbound track by a switch crew which also picks up completed units to be returned to service. The cars are inspected outside of the shop, and repair estimates are assessed. If it is determined that a particular car will require heavy repairs (i.e., more than 80 man-hours), it will be transferred to the "bad order" siding until slack time allows its processing. All trackage will be on level grade, with safety protection utilized where needed (e.g., placement of signal lights and/or signs at switches, vehicle crossings, etc.).



Source: Courtesy of
J.O. Davis,
Burlington Northern
District Office,
Billings, Montana

Figure 8.--Schematic of Laurel Coal Car Repair Shop

Step 2--The car is delivered to the transfer table and subsequently placed in the appropriate work bay by the operator using electrical controls and radio communication. All movement into and from the shop is accomplished by the table via automated disengagement of coupling of cars as directed by responsible shop supervision.

Step 3--All appropriate rods, levers, and chains are disconnected and the car body then is lifted sufficiently clear of the truck center pins and underbody using a 50-ton overhead crane. The wheels are rolled free, advanced to the truck monorail, and then moved to the grit booth using a five-ton hoist. The couplers and draft gears are dropped from the car ends, with body centerplate reconditioning, welding, and machining initiated immediately at both ends. Concurrently, the air brake and safety devices are tested and replaced if necessary.

Step 4--The disassembled trucks are sand-blasted (to bare metal surfaces) while positioned on a belt conveyor. The cleaned components then are inspected for cracks and defects (e.g., metal fatigue) by quality control personnel. All disqualified components are transferred to the reclamation (repair/scrap) shop. Replacement parts are fitted as needed, reassembled, and then moved by crane or manually, to the paint spray booths.

Step 5--Concurrent with Step 4, the car body sections which are worn or damaged are repaired or replaced. Discarded components are removed to scrap storage/salvage areas via forklifts.

Step 6--The qualified trucks are transferred by monorail hoist to the originating refurbished car. The wheels are installed, and the side-bearing clearance measured after the car has been set down on the reconditioned trucks. After the body is shimmed and centered, the car is lowered a final time. Final inspection of all rods, levers, handbrake chain, pins, etc. then is made.

Step 7--The transfer table removes the car from the work bay and places it on an out-bound track. A responsible shop supervisor will contact a transfer table operator by radio and inform him to make the move.

III.4.2 Economic Analysis

Introduction

The economic development of this proposed re-use will conform with the general approach taken in discussing the repair procedures and facility description. The reason for this is that a range of options for the placement of a facility at GAFB exists, and the option which is chosen will depend upon the market that can be developed. An economic discussion of the potential for placement of a facility at GAFB to service the current traffic on the BN line will be offered along with an economic discussion of the potential for a much larger repair station in the event large numbers of coal cars can be serviced at some future date.

Capital and Operational Costs - Small Rail Car Repair Facility

The economic viability of undertaking a rail repair operation at GAFB to service the current foreign line and private rail car traffic on the east-west BN line is not clearly defined and depends on what segment of the potential market can be captured. A problem exists in being able to specifically determine what types of repairs and maintenance functions could be attracted from the current rail traffic along the main line, and only estimates of the potential business opportunities can be made. On the other hand, the capital and operating expenses associated with a rail car repair facility are easily determined since there are many in existence.

A first order estimate of the market potential for obtaining repair and maintenance work from the existing rail traffic is made in the following discussions. The results of the estimate indicate that although a potential rail car repair and maintenance market does exist, contacts regarding business opportunities need to be made with rail lines other than the BN and contacts need to be made with private rail car owners to determine if specific business arrangements can be made.

Although exact statistics regarding the makeup of rail traffic along the BN route were not available, some estimates of the rail car traffic makeup were provided by various BN employees. More than 600,000 rail cars travel the BN east-west route annually, and just over one half belong to foreign and private lines. Of those that are not BN rail cars, about 20 percent belong to private owners. The private owners generally consist of large rail car leasing firms or large companies. It was also expressed that the presence of coal-carrying cars on this route was negligible.

A rail car repair facility that would be suitably tooled and staffed to perform heavy repairs at GAFB would be designed as discussed in the facility description given earlier. This basic facility could be scaled to handle between 250 and 1,000 rail cars annually for heavy maintenance work. The basic layout of the facility would remain the same whether 250 or 1,000 cars were processed, but some increase in equipment and trackage would be necessary to handle the larger number of cars. Also, the facility would operate with increased shifts and more manpower at the larger output. A rough estimate of capital and operating expenses for a facility designed to handle about 500 cars annually is outlined below.

Item	Cost
Trackage and switching (7,000 feet of track)	$ 500,000
Equipment (see facility description for details)	$1,000,000
Yard locomotive (600 horsepower)	$ 250,000
Building (110 x 250 feet costed at $\$20/\text{ft}^2$ includes power, heat, water, sewer and office space)	($ 550,000)[1]
TOTAL CAPITAL	$1,750,000

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[1] Capital cost not tabulated since facility exists at GAFB. A rental charge for the building is given under operational costs listed later.

To calculate the revenue that could be expected for the operation of such a facility, one could use the standard rates in the AAR Interchange Rules. These rates, currently $28 per hour, are fully burdened rates for all time charged directly to specific repair/rebuild jobs. If it is assumed that heavy repair jobs require an average of 60 man-hours, then an expected mean cost per car repair can be calculated as 60 hours/car x $28/hour = $1,680 exclusive of any profit made on parts.

Using the capital costs of the facility described above, a rate for unburdened labor, and a facility rental rate, one can calculate the number of cars that would need to be processed annually to cover the costs and provide some profit for the operation. This is done below.

Two types of operational costs are considered. First, the costs that are associated with rental and operation of the building will be considered as fixed. Secondly, the costs associated with paying the labor and management for each car processed (assuming 60 hours of work are required) can be calculated. The following labor costs are assumed.

$10/hour (average salary) x 60 hours = $600 x 1.35 (35 percent benefits) = $810 x 1.25 (25 percent management and administration costs) = $1,013 (average labor cost per car).

A tabulation of the capital and operational costs are shown below.

Item		
Capital (1,750,000 @12% annual interest, 20 year payback)	$231,228	annual costs
Building costs (110' x 250' building, $2.50 ft^2 includes utilities)	$ 68,750	annual costs
Labor (includes benefits, management and administration)	$ 1,013	cost per car

This analysis is not to be taken as a rigorous economic assessment of the costs and income expected from the operation of a rail car facility but only provides an approximate estimate of the costs associated with financing and operating a small facility and roughly shows the amount of repair work that would be needed to support such an operation. It is recognized that other costs such as expendables, machinery operation costs, etc. were not accounted for. However, for purposes of this discussion, these costs are not required.

The relationship between annual costs and annual income for the number of cars processed annually is shown in Figure 9 . From this figure, one can see that a minimum volume of about 400 rail cars for heavy repair at 60 man-hours per car is required to operate the facility at a break-even point. This would require that about 8 cars per week be processed.

Recall that the BN facility at Havre only handles heavy maintenance on about four or five BN cars per week and that just less than one half of the total traffic on that line is BN owned. This implies that if this facility could have the remainder of the heavy repair market, i.e., those cars belonging to foreign lines or private owners, only slightly greater than five cars per week would be available for repair. This number of repairs falls far short of the 8 cars per week required for the proposed operations to break even.

It is apparent that the existing density of incidental defective car repair traffic is probably not sufficient to support the rail car repair facility as proposed. The implication from the above discussion is that although the potential exists for a rail car repair facility to successfully operate out of the GAFB facility, major repair and maintenance contracts with foreign rail lines or private car owners would be needed to ensure the necessary volume of business.

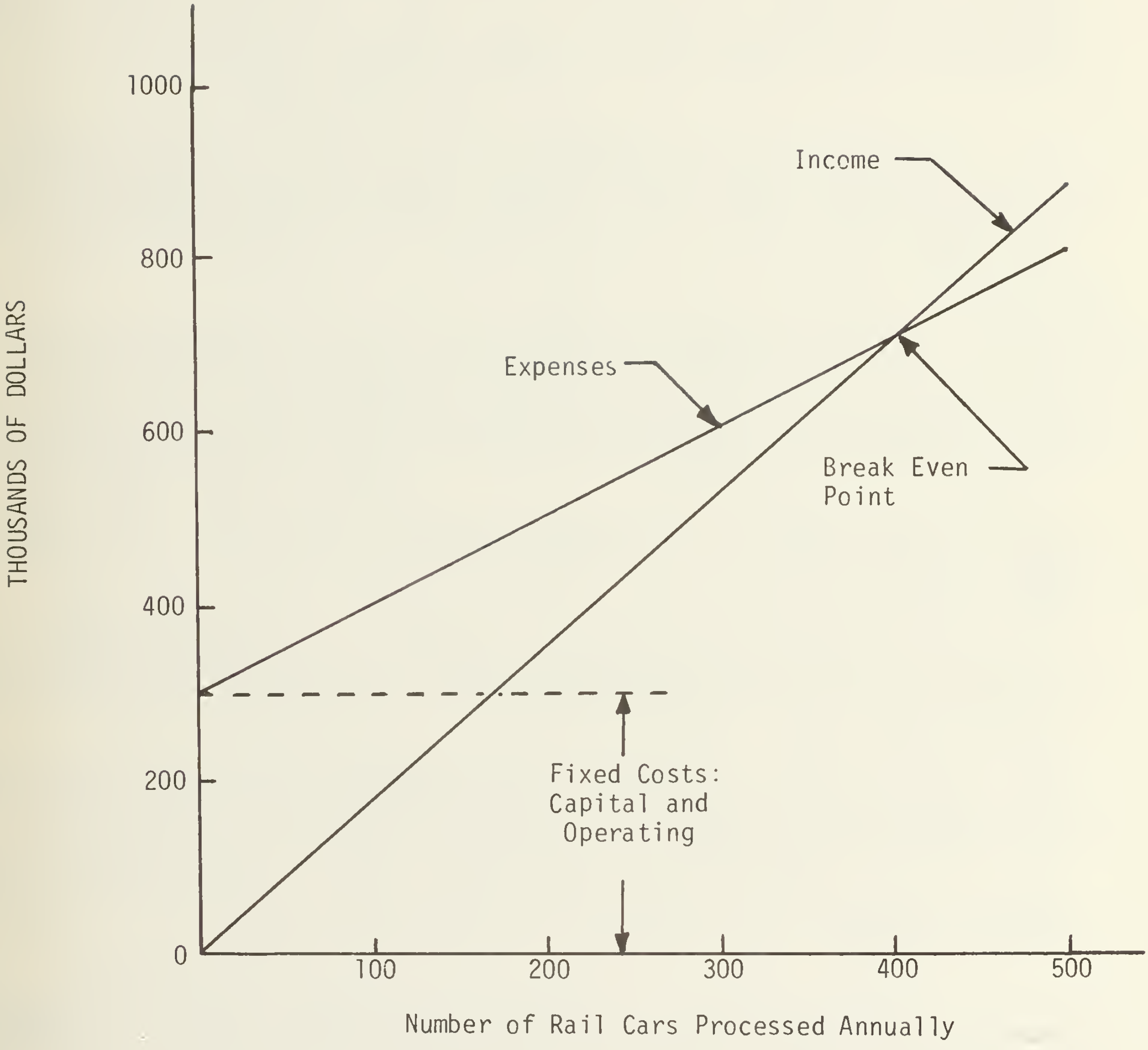


Figure 9.--Graph Depicting Break Even Point for Proposed Rail Car Repair Facility

Capital and Operating Expenses - Large Rail Car Repair Facility

If the coal export market similar to the one that exists in the subbituminous coal fields of southwestern Montana is to become established in the lignite deposits in northeastern Montana, the potential for a repair facility at GAFB to service coal carrying rail cars would exist. The extent of this potential would depend upon the amount of the coal mining activity and upon the proximity of the coal mine site to GAFB. As mentioned earlier, coal mined for the export market will be hauled from the mine site directly to the end use facility in unit trains. These unit trains will be subjected to high annual mileages, making a preventive maintenance program for these vehicles necessary.

Current trends indicate that there will not be an immediate need for exported lignite coals since there appears to be a substantial supply of subbituminous coals in Montana and Wyoming to meet the projected demands for several years. Therefore, an indepth analysis of the economic potential or operating costs for such a proposed facility is not deemed suitable at this point.

It is worthwhile to mention that a rail car repair facility designed to service unit trains for preventive maintenance would not be able to attract traffic from the southwestern coal operations. The reason for this is that the coal trains that leave this area travel mostly to the east and south with some traffic going west. None are routed in the direction of GAFB; nor is it expected that they will be in the future. Due to the necessity of keeping these unit trains in continuous service, they would not be routed to GAFB for maintenance because of the loss of service time that would be required to route empty coal trains from the coal fields to GAFB and return.

A very general overview of the capital and operating expenses is given in this discussion to give the reader an understanding of the economic scope of the proposed facility operations.

A maintenance facility sized and equipped to handle the proposed work load would cost on the order of $10 million dollars in addition to the existing facilities at GAFB, i.e., hangers, offices, utilities, etc. In addition, because the spur line would have to handle a high volume of rail cars, it would probably need to be upgraded. Such a procedure could be completed for about $100,000 per mile if much of the original rail materials could be salvaged.

If it is assumed that the capital requirements for a facility are about $12 million dollars (facility construction and upgrade of trackage), the following figures regarding annual operating costs for a facility placed at GAFB might apply.

Item	Annual Cost
Capital ($12,000,000 at 10% and interest 20-year payback)	$1,585,600
Building Costs (Two 110' x 250' buildings, $2.50 ft^2 includes utilities)	$ 137,500
Labor ($17/hr x 2,080 hrs/year, includes benefits, management and administration)	$ 35,566

These costs are exclusive of expendables, machinery maintenance, etc. and are only provided to give an estimate of the minimum number of cars that would need to be processed annually to keep such a facility operational.

The income that such an operation would realize comes from the difference in the loaded hourly labor rate paid as opposed to the hourly charge to the customer for shop time. The $28 per hour shop rate suggested by the AAR rules will be used for these purposes. The difference between the shop rate and loaded hourly wage is $11 per hour. This means that $11 of the charge to the customer would pay the capital and building expenses listed above and also pay other operating and maintenance expenses; the excess would be profit.

Discussions with BN personnel at the Laurel facility indicate that the average preventive maintenance man-hour requirement is about 25 hours per car, and about $2,000 in parts are required per car. Again, any costs and profit for parts transactions will not be considered in this discussion. If the annual costs for the proposed facility were the sum of the capital and building rental costs, i.e., $1,723,100, then about 156,645 hours of work would be required to cover these costs or 6,266 cars would need to be processed annually. This would be about 25 cars per day for a five day per week operation. If the facility were operated for three shifts a day, then just over eight cars per shift or two cars per shift per day for a four-day operation would have to be processed. This would require each bay to be manned by three men.

In such an operation a unit train could be processed through a preventive maintenance cycle in about four days. To break even, the facility would have to process about 63 unit trains annually.

It is important to remember that this analysis was provided for illustrative purposes only and that the actual costs and income required to operate such a facility can only be arrived at after a careful engineering analysis of a specific facility is made and contacts are made with the proposed customers.

The estimates shown here indicate that given a special set of correct conditions, a unit train maintenance facility can be a viable re-use of GAFB facilities. The conditions do not exist now though, nor are they expected to for some time.

III.4.4 Legal Requirement

Overview

An air emission permit may be required for continued operation of the residual oil-fired water heater system. The proposed (potential) wastewater settling pond will require review by the Water Quality Bureau. Solid waste disposal, either by incineration or landfill, may also require Health Department approval.

Indoor emission levels of fumes/vapors, sand blasting particulates, etc. arising from the blacksmith, painting, repair, and wood shops must satisfy Occupational Safety and Health standards. Noise levels also must satisfy standards.

Summary of Applicable Permits and Acts (also see Appendix B)

1) Major Facility Siting Act: Does not apply.
2) Air Pollution Permits: Oil-fired boiler may require review.
3) Water Pollution Permits: Wastewater settling pond will require review.
4) Solid Waste: Disposal of solid waste will require permission of the local landfill.
5) Hazardous Wastes: None (at this time).
6) Occupational Safety and Health: Indoor emissions of particulates, paint vapors, sand blasting, and other processes in the blacksmith, painting, repair and wood shops.
7) Water Supply: Present supply is adequate.
8) Power Supply: Present supply is adequate.
9) Off-Site Activity: None.
10) Miscellaneous: None.

The applicable permits and acts are detailed in Appendix B, Section 2.

III.4.5 Potential Environmental Impacts

Introduction

The development of a rail car repair facility at GAFB should result in no significant adverse environmental impacts on the GAFB area. The environmental impact was evaluated in regard to the following subjects which were considered in the environmental assessment and are summarized in the sections below: climate and air quality, noise, water quantity and quality, solid waste generation, land use, soils, vegetation, wildlife, and health and safety. Further discussion in these areas can be found in Appendix C.

Climate and Air Quality

No adverse or beneficial impacts are projected for a rail car repair facility. Gaseous and particulate emissions from automobile and railroad traffic will result from the operation of a repair facility. The cumulative impact from these sources, however, should be negligible.

Noise

A rail car repair facility should produce sound levels approaching 80 dBa within about 50 feet of the source. The operation of the facility will produce several different types of high-frequency noises that should be absorbed at the boundaries of the site. Workers would be required to wear protective ear plugs, but the overall noise levels outside the boundary of the facility should be negligible and are not expected to have any environmental significance.

Water Quantity and Quality

The present water delivery services at GAFB are adequate to meet the demand of a rail car repair facility. The facility should have a negligible impact on the aquatic environment. If not properly regulated or disposed, hydrocarbon drippings from the repair shop machinery could cause surface or groundwater contamination. However, close regulation and monitoring would eliminate this potential adverse impact.

Solid Waste

Solid wastes produced during the repair of rail cars include oily metallic shavings, small discards, packaging, and pollution control wastes. The disposal of these wastes at local landfills to meet federal, state, and local legal requirements will mitigate any potential impact.

Land Use

Existing GAFB buildings will be utilized for the rail car repair facility. The land near the buildings will be impacted by the rail track which is laid and outdoor salvage and storage, but the impact will be minor.

Soils

The construction of yard trackage, highway repair activities, and outdoor salvage/storage efforts could disrupt the soil structure by compaction or ripping effects. The impacts could be severe in the immediate area but pose no significant threat to the base or regional ecosystem.

Vegetation

The only potential impact on the vegetation in the area would be the deterioration of the rangelands and wildlife habitats due to the increased traffic in the area. This should cause only a minor impact though because of the relatively small population increase expected.

Wildlife

This alternative should have only a limited impact on the wildlife in the area. Some distrubance of game or mammal species will result from the operation of the facility (noise and vibration), but wildlife generally adapts to such disturbances. There also is the possibility of the spurline fencing interrupting antelope migration, but the relatively short length of the line minimizes this impact.

Health and Safety

The rail car repair facility will be constructed in compliance with all federal, state, and local worker health and safety requirements. Protective equipment will be provided to mitigate noise, dust, or other potentially hazardous conditions.

III.4.6 Social Impacts

Locating a rail car repair facility at Glasgow Air Force Base would have minimal, if any, negative social or economic impacts. Valley County's historical relationship with the railroad would help make such a facility compatible with community organization. Employment needs of the facility could accommodate much of Valley County's unemployed, and existing public facilities on the base could experience higher utilization. A breakdown of potential social impacts from this alternative is included in Appendix C.

Public Acceptance

The response to survey questions concerning a rail car repair facility located in Valley County was 71 percent in favor, 16 percent against, and 12 percent unsure. No significant negative socioeconomic impacts from the rail car repair facility re-use were anticipated by the agencies, organizations, and tribes in Valley County. All agencies, organizations, and tribes surveyed approved of the rail car repair facility re-use. The results from the survey are presented in Appendix D.

III.5 WIND ELECTRIC POWER PRODUCTION AND WIND TURBINE GENERATOR MANUFACTURING FACILITY

III.5.1 Introduction

On October 25, 1977, the Montana Energy and MHD Research and Development Institute (MERDI) began monitoring wind speed and direction at Glasgow Air Force Base (GAFB) using a 100-meter tower with recording instrumentation located at the ten-meter, 31.6-meter, and 100-meter levels. Wind speed and direction have been logged at 0.6 second intervals and recorded as ten-minute integrations for one full year. Graphs of the wind data depicting average diurnal wind velocity for the recorded periods are appended to this report (see Appendix E, Section 1). Also appended is a presentation on a weekly basis of the percentage of time that the wind velocity is at least 4.47 meters per second (ten miles per hour). Inspection of the graph reveals that velocities equal to or greater than this value exist approximately 70 percent of the time at the 31.6-meter level and are even more frequent at the 100-meter level.

NASA Lewis has established representative wind velocity profiles with annual frequency distributions to be used in designing wind generators. From the one year of data collected at Glasgow, it appears that the assumed NASA profile shape underestimates the wind energy potential in this region. As an example, the data measured at the ten-meter level is representative of a 4.3 meter per second (9.6 mph) average wind, whereas that measured at the 31.6-meter level, normalized to 9.14 meter height, is representative of a 5.6 meter per second (12.5 mph) wind. The 100-meter level measurements indicate an even higher average wind velocity. This means that the actual measured values at higher elevations are greater than the values assumed by NASA and the average winds at GAFB are better than predicted.

Assuming that these measurements are characteristic of the region, certain conclusions can be drawn. First, the wind energy potential is sufficient enough that the generation of electricity from large wind generators may be economical. Secondly, extensive widespread use of small-scale wind electric or mechanical energy does not appear feasible. This second conclusion is based upon the fact that the smaller generators in the one to four kilowatt size range are usually placed on lower height towers because of total system cost considerations. There will be places where terrain enhancement (i.e., valleys, ravines, knolls, etc.) will provide sufficient wind velocity near the ground so that these smaller generators will be economical, but the suitable area will probably be a small percentage of the total area available. Additional ten-meter height wind velocity measurements must be made to confirm this conclusion and identify the terrain-enhanced areas.

Two business opportunities are possible for GAFB with respect to the large wind electric generator class. One is associated with a wind electricity generation "farm" of numerous large generators on the base or in the surrounding area. Such a wind farm would have to be closely coordinated with aeronautical re-use of GAFB. The other and probably the most practical wind re-use is one that would use the base facilities to manufacture and assemble large wind generators for use at a wind farm or individual sites within a radius of a few hundred miles of the base. The spacious hanger facilities would be well suited for such a use. The maximum radius of the area that could be serviced from the base is dependent upon many factors, the resolution of which is unknown at this time; however, the base facilities could provide significant support for a wind farm of 25 to 100 MW that was centered within 50 to 70 miles of the base. Such a re-use is obviously dependent upon establishing the need and the comparative economics of an electric wind farm in the Glasgow area.

III.5.2. Wind Farm and Manufacturing Facility Description

Wind Farm Discussion

The U. S. Department of Energy (DOE) has supported the development and manufacture of large wind generators for the past few years. The horizontal axis design has advanced the furthest under the technical direction of NASA Lewis. The Boeing Construction Company and the General Electric Company have been prime hardware contractors. Figure 10 depicts a Boeing 2 MW horizontal axis upwind design. Under the direction of the Sandia Laboratory, advanced vertical axis wind generators are being designed and manufactured by the Aluminum Company of America (ALCOA). Figure 11 is a representation of a vertical axis wind turbine generator. This figure was taken from a Sandia Laboratory report on vertical axis wind turbines written in 1974. Today, most of the effort in this program has been directed at generators of less than 100 KW. Current design work has included generators of 250 and 500 MW. The vertical axis generator, using the Darrieus concept, may have a performance advantage over the more conventional horizontal axis concept in the lower wind velocity regimes. If this proves to be true, then the vertical axis generators may find greater application than horizontal axis generators in the Northern Great Plains region which is characterized by ample but not high wind energy potential. Since development has proceeded much further on the horizontal axis generators, this assessment will consider only this type. Preliminary cost estimates from ALCOA indicate that its vertical axis generators will be about the same or slightly lower in price than the horizontal axis machines.

The Montana International Trade Commission (MITC) has proposed to conduct a demonstration project at GAFB using Sandia developed Darrieus wind generators for DOE. DOE has funded the design and manufacture of five 200-KW horizontal axis generators which are currently being, or scheduled to be, tested at various locations in the United States, Puerto Rico, and Hawaii. In addition, General Electric (GE) has manufactured a 1.5 MW generator for testing in North Carolina, and Boeing is scheduled to manufacture three (MOD-2WTS) 2.5-MW generators. The first MOD-2 WTS, currently under development, is scheduled to be in fabrication in mid-1979. Installation and initial operation of this unit are scheduled for early 1980 at a site to be selected in mid-1979. Options to fabricate and install as many as three more units are to be exercised by DOE in early 1979. Additional units will be fabricated and installed on a commercial basis as early as mid-1981.

Boeing has supplied preliminary manufacturing, operational, cost, and performance data on its generator, and General Electric has performed an indepth study of a 500-KW and a 1500-KW generator. Since more information is

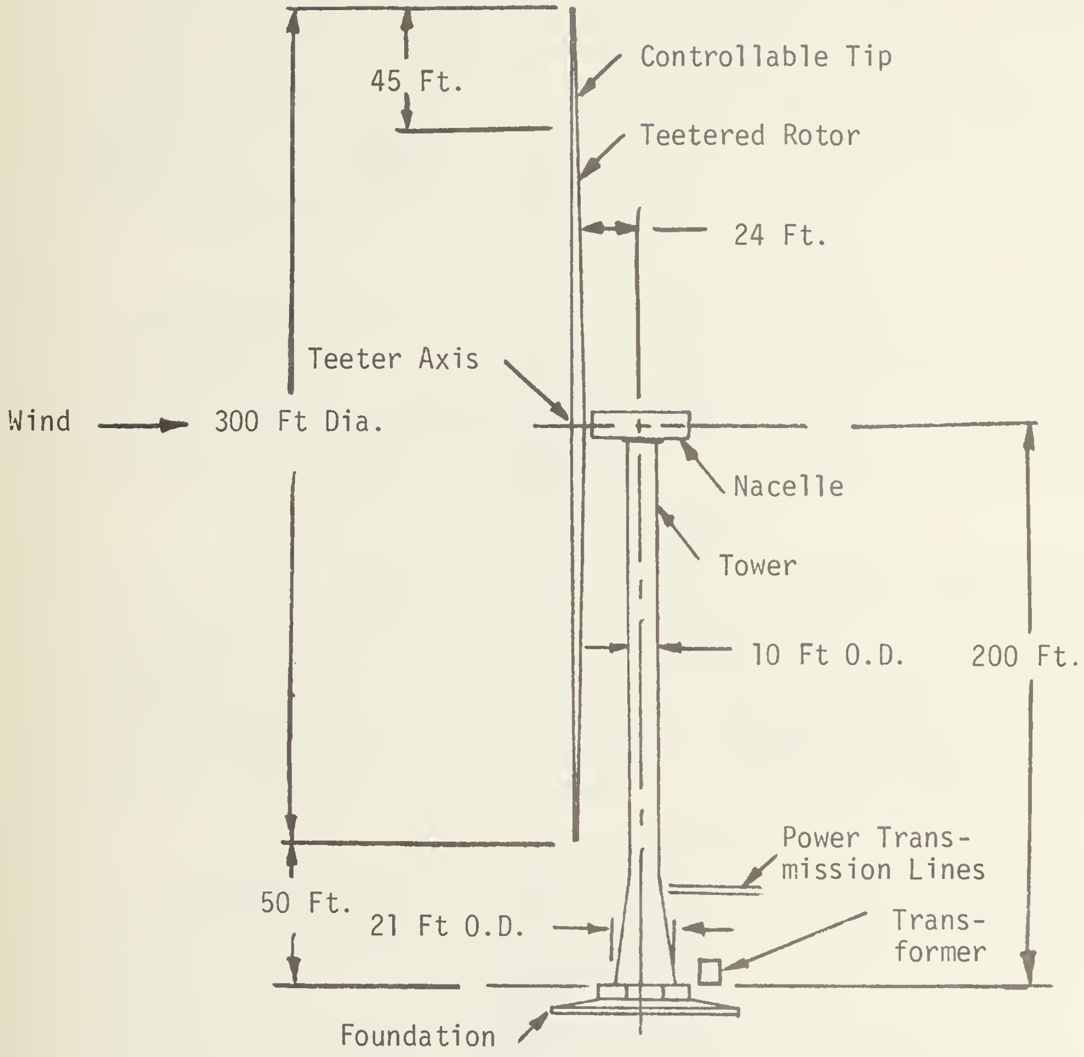


FIGURE 10.--Boeing 2 MW Wind Turbine Generator

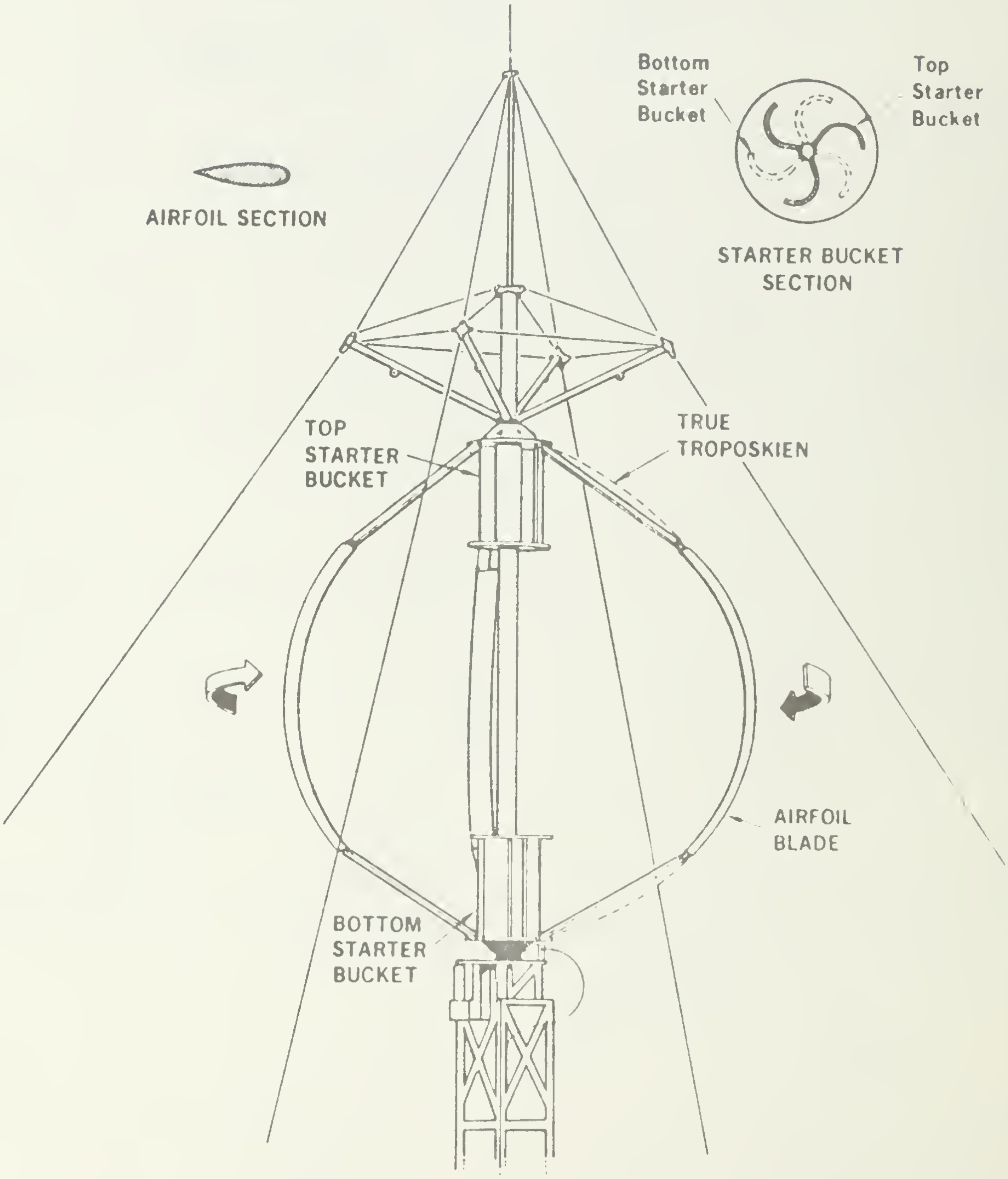


FIGURE 11.--Vertical Axis Wind Turbine

available on the Boeing MOD-2WTS, it is referenced more extensively throughout this section. It should be noted that the final cost of electricity per kilowatt hour is dependent upon the assumed average wind velocity. The General Electric study assumed a 12-mph median wind site for the 500-KW generator and an 18-mph median wind site for the 1.5-MW generator. As a result, when all the costs were accounted, the 500-KW machine generated electricity at 4.04¢/KW-hr and the 1.5 MW machine generated electricity at 1.57¢/KW-hr using 1976 dollars. The Boeing Company computed cost in 1977 dollars is 3.7¢/KW-hr for its 2.5-MW generator which assumed an average wind speed of 14 mph for design. All of these costs are for production model generators and not for the generators that are currently under manufacture. Figure 12 shows a graph of electricity cost as a function of mean wind speed for the Boeing MOD-2 WTS. The capital and maintenance costs of the first generators will most likely be higher than those of the later models.

As an example of the maintenance cost, Boeing estimates that for a 25-unit wind farm the annual cost for maintenance will be $15,000 per machine using a two-man crew. Figure 13 depicts the Boeing operations and maintenance costs. In terms of the cost per generated kilowatt, the General Electric generators would require 0.66¢/KW-hr for 500 KW and 0.24¢/KW-hr for 1.5 MW. The capacity factor for the three machines varied from 42 to 51 percent and is highest for the higher average wind velocity regime.

From this data, it can be seen that given the current trend in fuel and electricity costs and in electricity need, wind-generated electricity may become competitive in the near future. The first sites selected for wind electric generating farms will be those with the best economics. The GAFB facilities, the regional wind energy potential, and the Fort Peck Reservoir generators and distribution system provide such an advantage to the Glasgow area. Figure 14 depicts another Boeing 2 MW machine which shows the tower, foundation, and facility layout required at a site.

The U. S. Army Corp of Engineers is currently studying an alteration in the current generating concept at its upper Missouri River dam sites. Because of the costs and operating characteristics of the new power plants that are being designed and constructed, it is desirable from an economic point of view that these plants be operated in a base-load mode. The new proposed concept is that hydroelectric generation be used as peaking capacity. To maximize the peaking capacity, it has been proposed that additional generation be added at Fort Peck and that a small re-regulating dam be constructed below the present dam to provide control for regulating the downstream river flow. In the proposed plan, the generating capacity would be increased to 350 MW; however, this could only be used for eight hours per day six days a week. The remainder of the time, no water would flow from the main dam. The flow below the re-regulating dam would vary during the week, but the variation would be less than is currently experienced.

The opportunity to couple hydroelectric generation with a re-regulating dam and wind generated electricity in the same region will add considerable flexibility and increased productivity to both systems. The general seasonal characteristic is that the maximum wind occurs during the time of minimum water flow. This is in the winter when the electricity

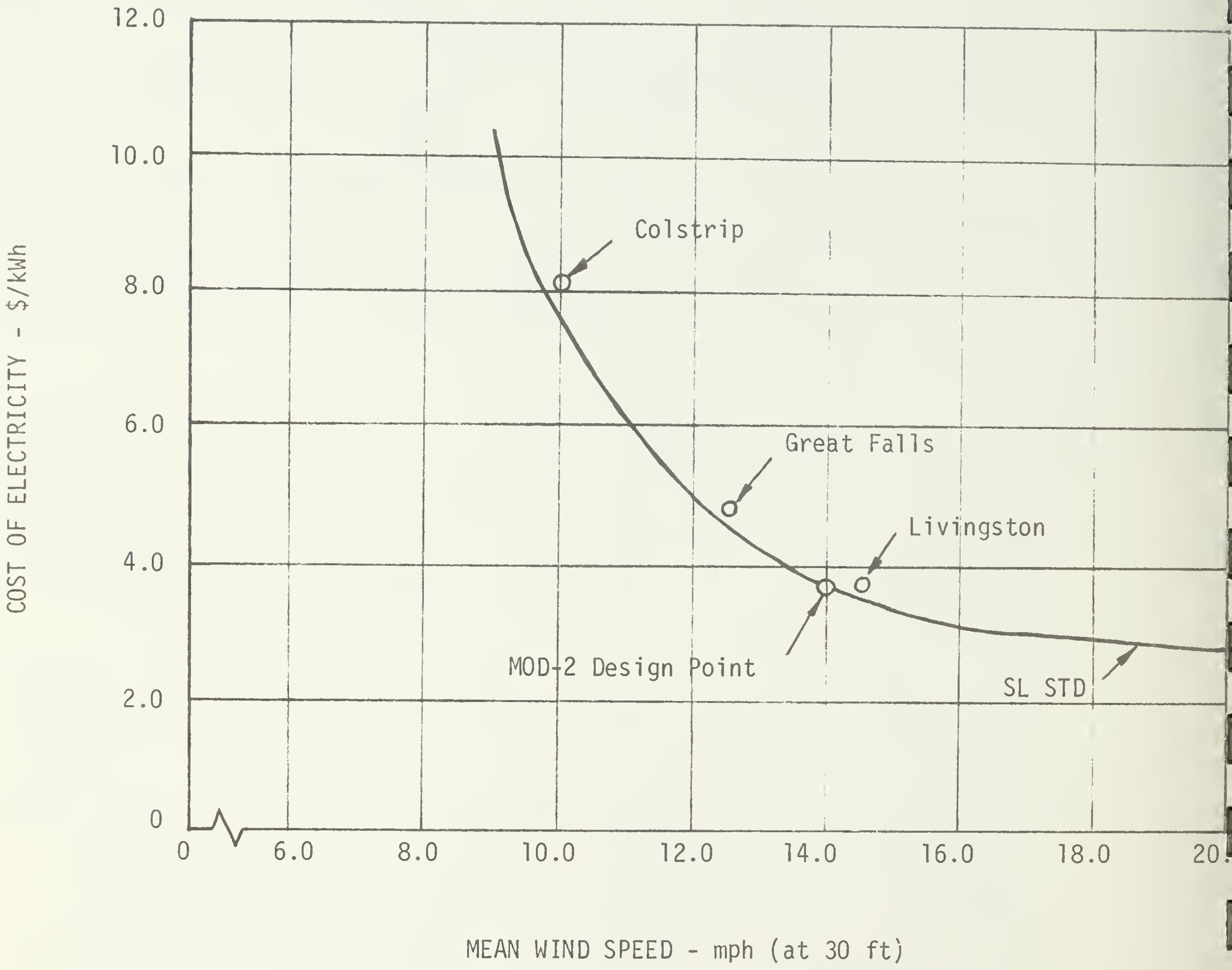
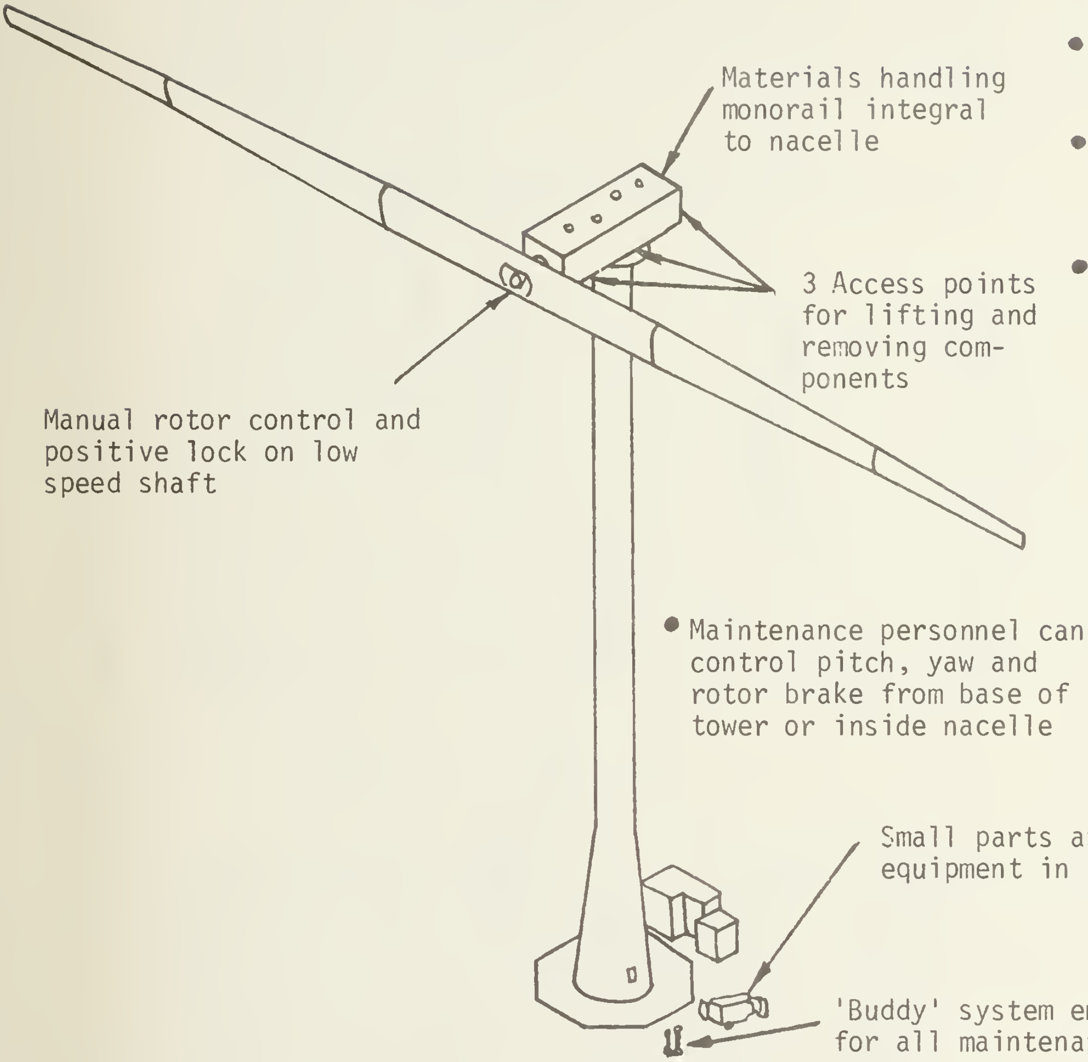


FIGURE 12.--Boeing MOD-2 WTS Cost of Electricity

Maintainability Features


Materials handling monorail integral to nacelle
3 Access points for lifting and removing components
Manual rotor control and positive lock on low speed shaft
Maintenance personnel can control pitch, yaw and rotor brake from base of tower or inside nacelle
Small parts and test equipment in van
'Buddy' system employed for all maintenance

Maintenance Concepts and Costs

- 2 shift coverage, 2 man crews, 6 days per week
- Outside services used for shop repairs, special tasks and heavy equipment rentals
- Annual O+M costs for WTS (for 25 unit farm)

Labor	$8,000
Materials, parts and outside services	$7,000
TOTAL	$15,000

FIGURE 13.--Boeing Operation and Maintenance

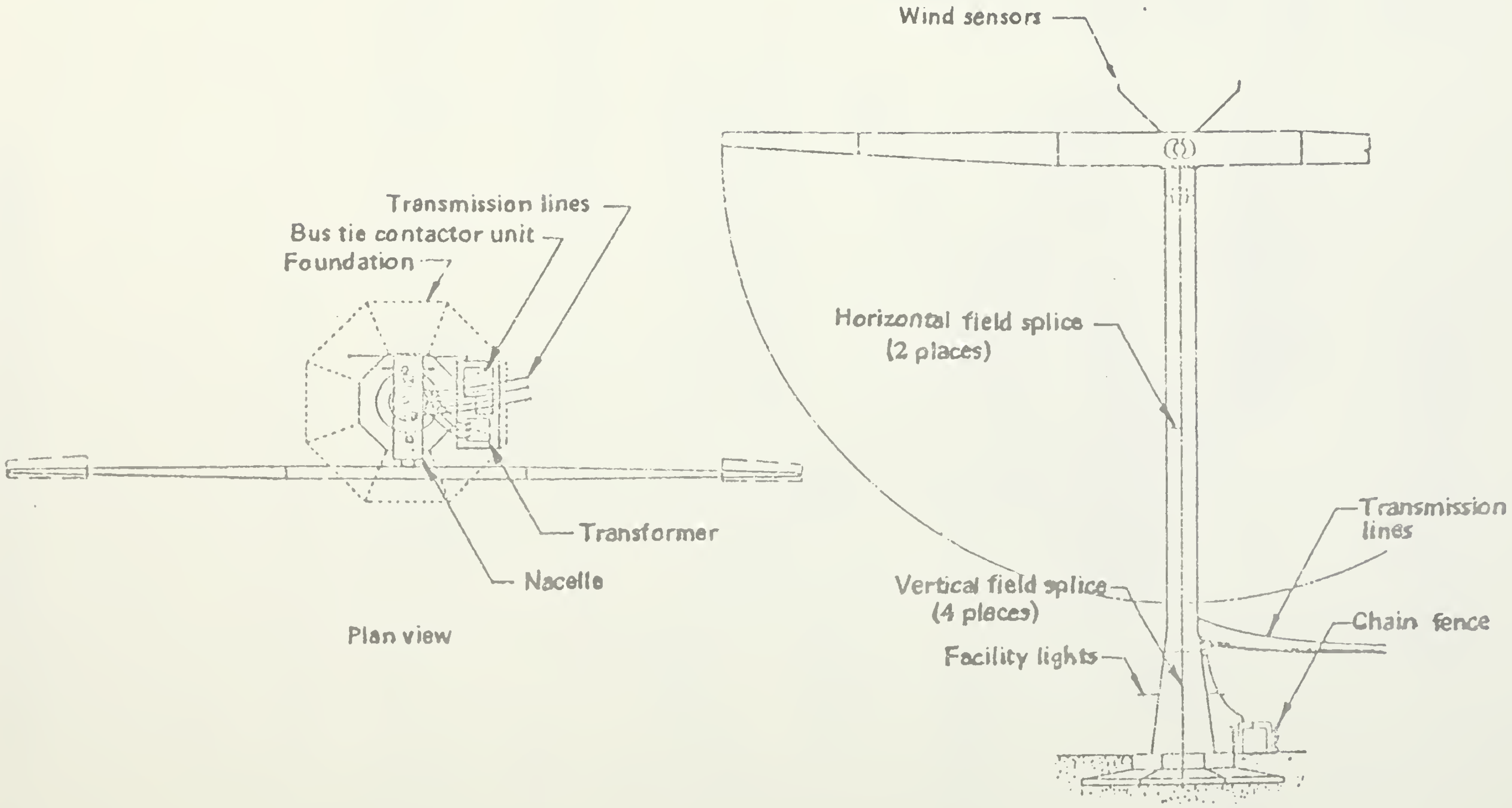


FIGURE 14.--Boeing Tower, Foundation and Facility Layout

need is the greatest. The minimum wind occurs during the maximum water flow period. Wind generated electricity could extend the daily peaking capacity period for a few hours each day.

The manufacture of large size wind machines to generate electricity in wind farms in conjunction with Fort Peck Dam or for rural electric cooperatives in northeastern Montana appears to be the most likely early use of GAFB facilities for wind generator manufacture. The Corps of Engineers, Basin Electric, and rural electric companies should be encouraged to consider and study the generation of electricity by wind power immediately.

Manufacturing Facility Description

Introduction

The scope of operation for wind turbine generator manufacturing at GAFB will be determined mainly by the actual work to be performed there. It is unlikely that facilities would ever be installed at GAFB for producing the materials needed in the construction of wind turbines. For the most part, materials (i.e., steel) and components (i.e., generators, transmissions, etc.) would have to be shipped in by rail and/or truck. The most probable type of plant would be a production-line assembly plant for manufacturing or fabricating wind turbine generators and towers. Obviously, the first step would be to locate an existing company with mass production capability and then interest the company in locating at GAFB. If this is not possible, then a new company would have to be formed. Regardless of the machine size (or range of sizes) which is selected for manufacture, it is probable that the existing facilities could be adapted to meet requirements for manufacture or fabrication.

Fabrication Description

In very general terms, the type of work to be performed will be fabrication and assembly. The tower sections will be bolted together depending on section size and transportation distance to the site. Also, the blades can be manufactured and assembled at the facility. The generators, shafts, transmissions, and all other components will have to be positioned in the "nacelle" and secured in place. All wiring and controls will have to be installed. Unless the entire units can be transported by helicopter, the blades will have to be installed on the site where they will be operated. Again, the exact steps for this assembly process are not known at this time.

Plant Description

Due to the cold temperatures, high winds, and snow conditions at GAFB, the facilities would have to be housed in permanent buildings and would require rail access. Four buildings which may be used for this facility are Buildings No. 656, No. 648, No. 654, and No. 646. The area between the buildings could be used for steel yards, storage, and parking. The only major modification to these buildings would be the installation of heavier overhead traveling crane mechanisms. Depending upon the size of machines, blades, and towers to be fabricated, larger (up to 50-ton) cranes might be required. Also, various equipment such as welders, metal working equipment, hand tools, spray paint facilities, forklift trucks, etc. would have to be installed in the buildings as needed. Boeing Company has indicated that for a manufacturing facility capable of producing four 2-MW wind turbine generator systems per month, the total area requirements would be 480,000 square feet. This would include 204,000 square feet for the factory itself, 28,000 square feet for the office facilities, 52,000 square feet for a steel yard, and 196,000 square feet for a parking area. The facility being discussed for GAFB is one capable of producing two 2-MW wind turbine generator systems per month. By using the four buildings referred to above and the space between them, ample facilities could be provided. Figure 15 shows the plant layout for the Boeing production plant. It is shown for illustrative purposes only because the plant at GAFB would utilize several buidings and be different in the final design. However, similar work stations and equipment would be required.

111.5.3 Economic Analysis

In a mass production status, the Boeing wind generators are projected to cost $829 per KW in 1977 dollars and $1,320 per KW in 1985 dollars. Table 10 is a cost forecast presented by Boeing Company for its 100th production unit in 1977 dollars. The on-site manufacture or buy decision on the individual components has not been made by either company and would depend upon many factors. Representative numbers on the large 1.5- to 2-MW generators indicate that on the order of 10 to 20 man-years are required for some manufacture and final assembly. The generator weight including the tower is estimated at 500,000 to 700,000 pounds with over one-half of the weight in the supporting steel tower. The drive shaft, gear box, bearings, bed plate, and generator will weigh from 70,000 to 120,000 pounds and will, in all probability, be shipped as sub-assemblies. The rotor and blades are the remaining major sub-assembly. Even the largest blades could be made in the facilities on the base. A reasonable labor estimate for blade manufacture and generator assembly is 20 man-years per generator plus supporting overhead and administrative personnel given a labor charge of $400,000 to $500,000 per generator. Electronic control and utility grid connecting equipment could also be produced on base; however, in this analysis, these sub-assemblies are not included.

For a wind generator farm of 150 MW installed over a two-year period, 75 generators would have to be manufactured for an average of three per month employing a labor force with an annual payroll in excess of $15 million. Additional workers would be required for the site preparation and generator erection which is estimated at three man-years per generator. This would represent a significant initial manufacturing and construction period of the wind farm from two to four years.

A wind farm of this size would require about 50 people year around for operation and maintenance. In addition, ten to 20 people would be required for administrative and major overhaul activities. In summary, the manufacture of 18 generators per year and the operation and maintenance of a 150 MW wind generator farm in the Glasgow

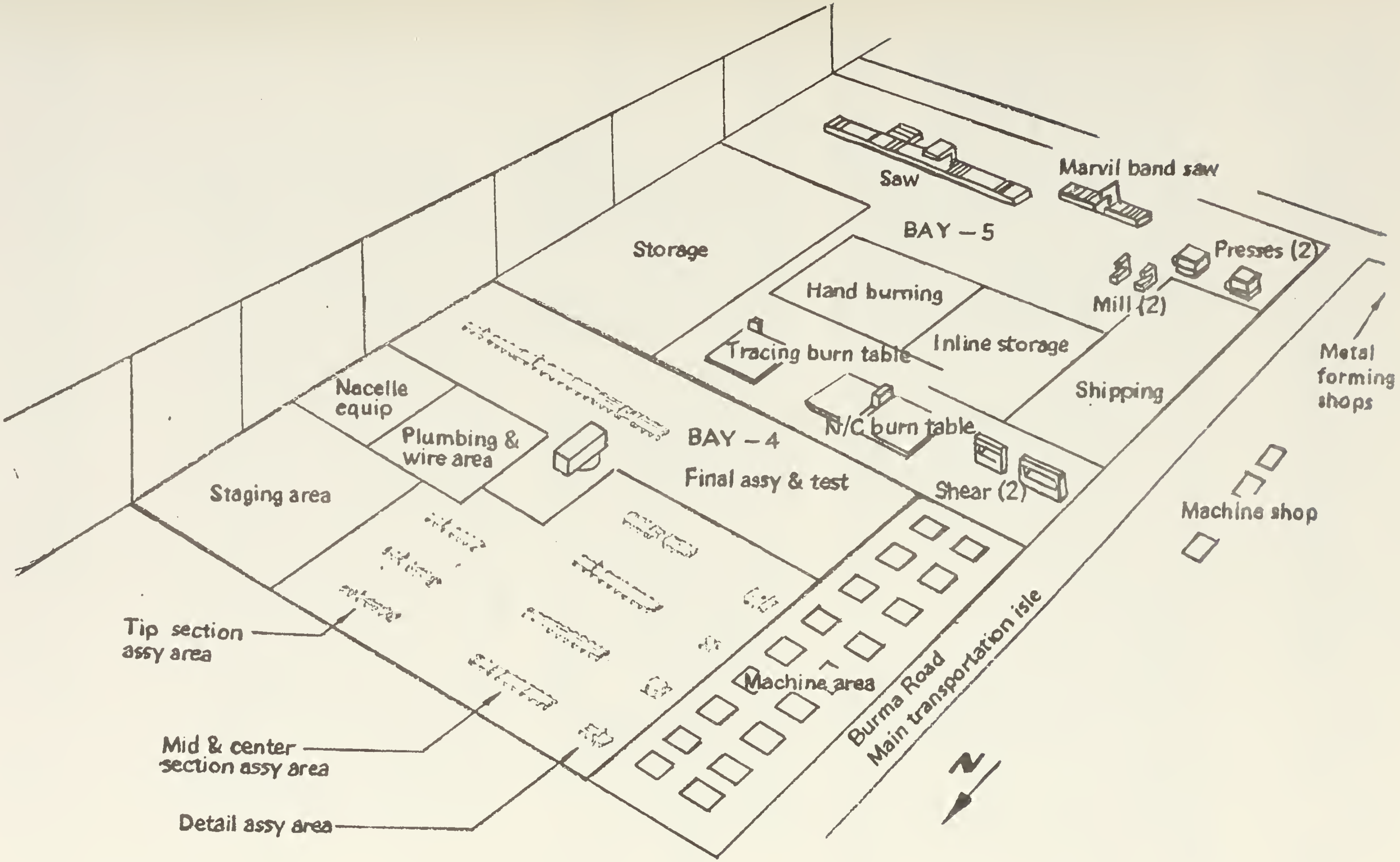


FIGURE 15.--Boeing MOD-2 WTS Manufacturing Facility Layout

Table 10.--Boeing MOD-2 WTS Cost Forecast
(100th Production Unit, 1977 Dollars)

	Turnkey Cost Account	
1.	Site Preparation	$162,000
2.	Transporation	29,000
3.	Erection	137,000
4.	Rotor	329,000
5.	Drive Train	379,000
6.	Nacelle	184,000
7.	Tower	271,000
8.	Initial Spares	35,000
8.	Non-Recurring	35,000
9.	Total Initial Cost	$1,561,000
	Fee (10%)	156,000
	TOTAL TURNKEY	$1,717,000

Total Cost Exposure	
Total Turnkey Cost	$1,717,000
Interest During Construction	35,000
Land, Rightaways and EIS	23,000
Transmission and Communication	27,000
Contingency (15%)	270,000
TOTAL WTS COST EXPOSURE	$2,072,000

Per kW Cost

With 6% per Year Inflation Rate

1977	829 $/kW
1985	1,320 $/kW

area would employ about 400 people, and about 200,000 square feet of manufacturing space would be required. The level of manual skills of the individuals would range from intermediate to high and would include welders, electricians, heavy equipment operators, etc. This level of operation could be housed at GAFB as discussed in the previous section.

A standard unit of energy measurement is one million Btu which corresponds to 293 KW-hr. Again referring to the Boeing MOD-2 WTS, a cost of electricity determination is shown in Figure 16; the projected cost is 3.7¢ per KWh. At 3.7¢ KW-hr, this corresponds to $10.84 per million Btu which, from Figure 17, is a number that can be expected by 1982 or 1983. Wind-generated electricity is not economical today, but it will be in the near future if the estimated cost of producing wind generators can be met. The Boeing Company states that "It is anticipated that the Mod-2WTS will be employed by utility companies in arrays of several units. Energy cost comparisons show that the cost of electricity from such WTS arrays will be competitive with conventional power plants within the 1985 time frame."

In concluding the economics section, the projected cost of wind electric power should be compared to the projected cost of conventional energy sources.

> "As an example of the projected relative economics of MOD-2 WTS, energy pricing results for the MOD-2 WTS have been developed and are shown on Table 11 in conjunction with similar energy pricing data extracted from recent economic studies by Portland General Electric (PGE) and the August 1977 Electric Power Research Institute (EPRI) Technical Assessment Guide. Results shown in the table illustrate the build-up of cost of electricity and demonstrate the relative economic ranking of WTS with nuclear, coal and oil-fired conventional power generation system.
>
> Two types of WTS plants have been configured and priced. The first WTS plant shown is a 25 unit farm operating in a fuel-saver application. This plant has a fixed annual energy output of 244 x 10^6 kWh (capacity factor = 44.5%). It has no fuel cost and a moderate O & M cost due to the relatively large number of units. In the 1985 time frame, the 5.9¢/kWh total energy costs of the fuel-saver WTS must compete with the 2.5 - 6.7¢/kWh operating costs of the conventional power generation equipment. It appears that WTS in this application will compete successfully with oil and gas fired generation equipment, and may eventually become competitive with coal."[1]

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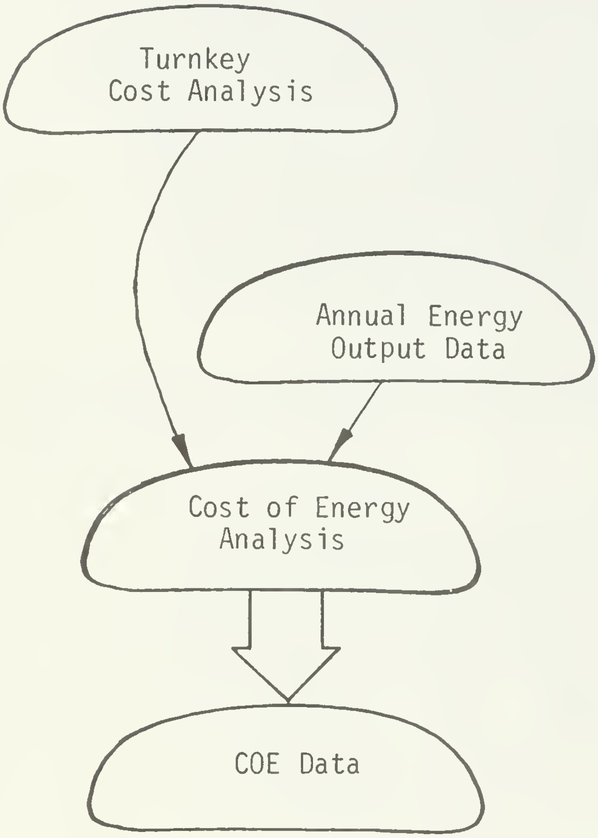
[1] 2,500KW Wind Turbine System For Electric Power Generation, MOD-2 Project Technical Summary, Boeing Engineering and Construction Company, January 18, 1979



Cost of Electricity

$$COE = \frac{IC \times FCR + AOM}{AEP}$$

FCR = Annualized Fixed Charge Rate = 16% Per Year

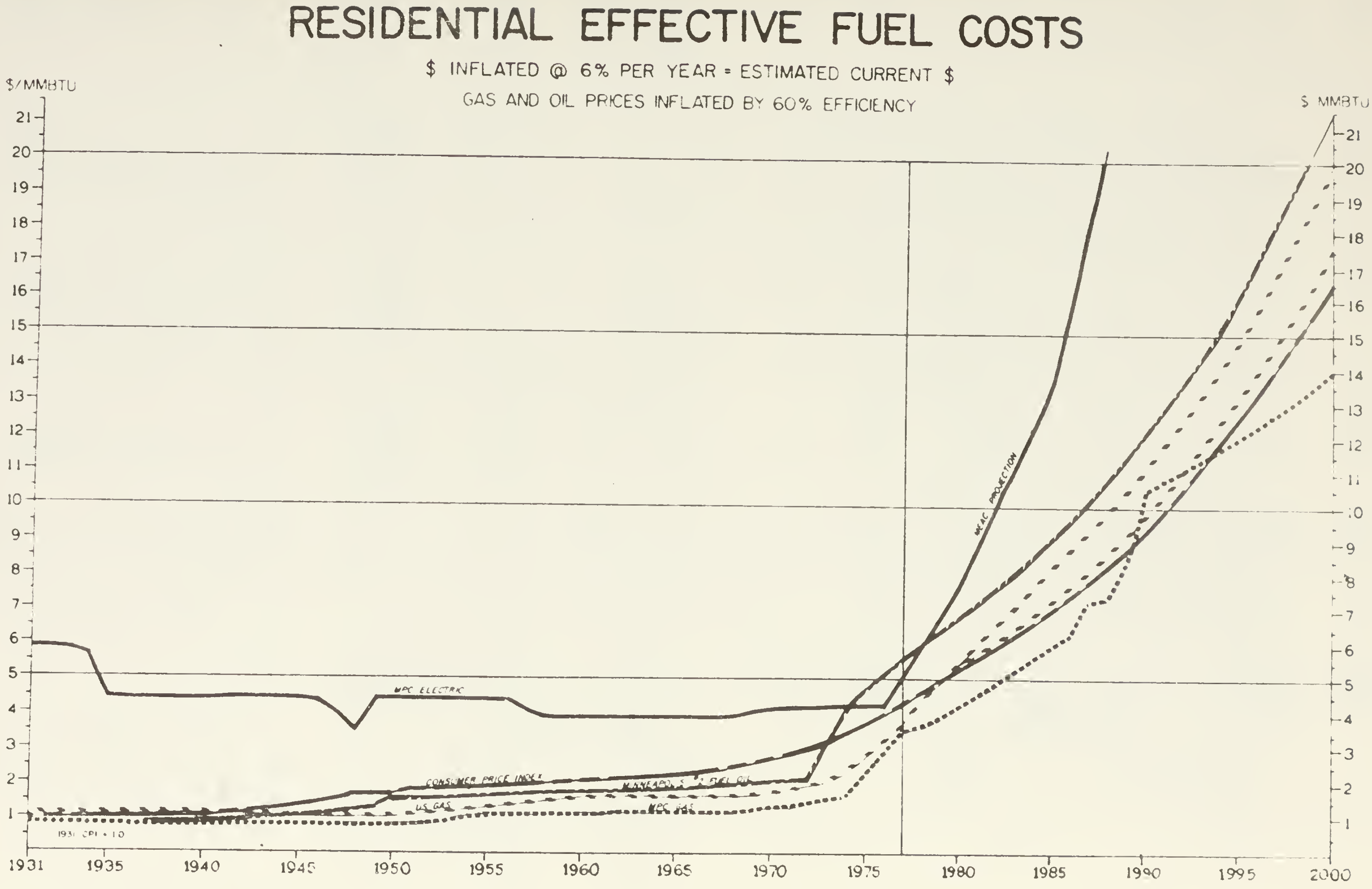
IC = Total WTS Cost Exposure = $2,072,000

AOM = Levelized Annual Operations & Maintenance Cost = $30,000

AEP = Annual Energy Production = 9.75×10^6 kWh

COE = 3.7¢/kWh

FIGURE 16.--Boeing MOD-2 WTS Cost of Electricity



Sources: "Gas Facts" American Gas Assn.
U.S. Bureau of Labor Statistics
MPC data

FIGURE 17.--Residential Effective Fuel Costs

16% Levelized Fixed Charge Rate 30 Year Service Life		In Service 1976					In Service 1985				
		Conventional (EPRI Est)			MOD-2 WTS		Conventional (PGE Est)			MOD-2 WTS	
	Capacity Factor %	Nuclear	Coal	Oil	Fuel Saver	WTS + 80% Oil	Nuclear	Coal	Oil	Fuel Saver	WTS + 80% Oil
Rated Capacity (MW)		1000	1000	400	62.5	500	1200	600	400	62.5	500
Total Cost Exposure ($/kW)		785	661	285	782	1,010	1220	1320	454	1,320	1,683
Levelized Fixed Costs, ¢/kWh	30	4.8	4.0	1.7			7.3	8.0	2.7		
	44.5	3.2	2.7	1.2	3.2	4.1	5.0	5.4	1.9	5.4	6.9
	50	2.9	2.4	1.0		3.7	4.4	4.8	1.7		6.1
	70	2.0	1.7	.7		2.6	3.1	3.5	1.1		4.4
Levelized Fuel Cost, ¢/kWh	All	1.2	1.8	3.1			2.0	3.5	6.3		
	44.5				0	0				0	0
	50					.3					.7
	70					1.1					2.3
Levelized O & M Cost ¢/kWh	All	.2	.4	.3			.5	.5	.4	.5	
	44.5				.3	.4					.6
	50					.4					.6
	70					.4					.5
Levelized Total Energy Cost, ¢/kWh	30	5.2	6.2	5.1			9.8	12.0	9.4		
	44.5	4.6	4.9	4.6	3.5	4.5	7.5	9.4	8.6	5.9	7.5
	50	4.3	4.6	4.4		4.4	6.9	8.8	8.4		7.4
	70	3.4	3.9	4.1		4.1	5.6	7.5	7.8		7.2

TABLE 11.--Comparative Economics of Alternative Energy Systems

Boeing Company (1978)

> The second WTS plant shown in the table [see Table 11] is a 200 unit farm that operates in conjunction with a modern 400 MW (80% of the WTS rated power) oil-fired backup power generating system. The backup plant provides all of the combined generating system energy output in excess of the fixed 44.5% capacity factor of the WTS. When the combined system is operating at a 50% capacity factor, 11% of the annual energy comes from the backup unit, and at 70% capacity factor, 36% of the annual energy comes from the backup unit. The total costs of the combined system are based on the MOD-2 WTS estimates combined with PGE and EPRI oil-fired unit costs for the respective comparisons. In the 1985 time frame, the 7.4¢/kWh (50% CF) total energy cost of the combined WTS must compete with 6.9 - 8.4¢/kWh electricity from conventional power generation equipment. With the 20% capacity credit, the MOD-2 WTS now has a clear competitive advantage over coal and oil, and is even marginally competitive with nuclear at intermediate capacity factors."

III.5.4 Legal Requirements

Overview

The wind generator production facility will require relatively few environmental permits. Occupational Health and Safety regulations must be complied with and solid wastes must be properly disposed of, but there appears to be no need for air or water permits (unless solid waste is incinerated on site).

The wind farm construction will involve greater potential impacts and more regulatory review. If such a facility is large enough, certification under the Major Facility Siting Act will be required. Erection of the generator towers and construction of power lines will involve land disturbances which may require review by a variety of local, state, and federal agencies.

Ordinarily, generation of electric power for ultimate public consumption is regulated by the Public Service Commission (PSC). However, if an electric cooperative association conducts the project, the PSC does not have jurisdiction.

Summary of Applicable Permits and Acts (see Appendix B also)

1) Major Facility Siting Act: Will apply if wind farm generates 50 MW_e.
2) Air Pollution Permits: Possibly required (pending final process/plant design).
3) Water Pollution Permits: Possibly required (pending final process/plant design).

4) Solid Waste: If incinerated, air permit review may be necessary. Note that a Class III disposal site will be sufficient; safeguards against leaching and water pollution probably not required.

5) Hazardous Wastes: None envisioned at this time.

6) Occupational Safety and Health: Indoor noise and emission standards.

7) Water Supply: Existing supply is adequate.

8) Power Supply: Existing supply is adequate.

9) Off-Site Activities: Construction of wind farm: erection of generation towers and transmission lines.

10) Miscellaneous: Utility company regulations.

A detailed discussion of the applicable laws and permits can be found in Appendix E, Section 2.

III.5.5 Potential Environmental Impacts

Introduction

The development of a wind generator manufacturing facility and the establishment of a wind farm at GAFB should have no adverse impacts. Overall, the use of the base facilities and surrounding Valley County land for both the manufacturing facility and wind farm should be considered moderately beneficial. The following subjects were assessed in regard to the potential environmental impact of the proposed re-use: climate and air quality, noise, water quantity and quality, solid waste generation, land use, soils, vegetation, wildlife, health and safety, television and radio, and visual and aesthetic acceptance. These aspects are summarized in the following paragraphs. A more detailed discussion can be found in Appendix C.

Climate and Air Quality

No adverse or beneficial impacts are projected for a pilot-scale wind farm and manufacturing facility. A medium- or large-scale wind farm will alter microclimatic conditions (localized climate patterns) by increasing the roughness of the earth's surface in the vicinity of the wind generating towers. Local patterns of temperature, precipitation, snow drifting, and evaporation might be modified. Gaseous and particulate emissions from automobile and railroad traffic will result from the siting of wind turbines and the operation of a manufacturing facility. The cumulative impact from these sources should be negligible. The assembly of wind generator components may involve gaseous and/or particulate emissions uncharacterized at this time because of the unknown production process scenario.

Noise

The wind turbine manufacturing facility should produce sound levels approaching 80 dBa within about 50 feet at the source. The wind farm at any scale will produce several different types of high-frequency noise that should be absorbed at the boundaries of the wind farm. Low-pitched, rumbling infrasound will also be produced by the generating towers. Workers may be required to wear protective ear plugs, but the overall noise level outside the boundary of the facility should be negligible and is not expected to have any environmental significance.

Water Quantity and Quality

The present water delivery services at GAFB will be adequate to meet the demand of a wind generator manufacturing facility. The production of wind turbines may involve minimal effluent discharge (i.e., paint and metal working residuals) and may result in localized siltation and erosion in the immediate vicinity of the wind farm. However, process effluents and domestic sewage should be handled adequately with the existing sewage system and treatment facility.

Solid Wastes

Minor structural modifications to the GAFB facilities proposed to be used for production may result in small quantities of metal and wood wastes, but they can be salvaged by local residents or transferred to a local sanitary landfill.

Land Use

Existing GAFB building will be utilized in the implementation of the wind turbine manufacturing facility. Several square miles (sections) of land will be required for the development of the wind farm. The present or beneficial use (mostly grazing) of these adjacent lands will not be impaired by the siting of wind generating towers.

Soils

Compaction or surface disruption of soil profile will result from the erection of wind towers within the wind farm's boundaries. Other localized soil disturbance could result from spur line and highway repair and the development of access roads.

Vegetation

Upland level vegetative communities including western wheatgrass (*Agropyron smithii*) and junegrass (*Koeleria cristata*) in the vicinity of the wind farm will be slightly disrupted by the erection of wind generator towers. These areas should revegetate naturally. Minor deterioration of rangelands and wildlife habitat may result due to increased traffic in the area. These impacts, however, should be considered minor.

Wildlife

The actual construction of the wind generator towers would be the greatest disturbance factor. Siting the turbines on a high grassland bench may disrupt a few scattered pronghorn antelope (Antipocapra americana) and a few songbird species. The operating generators could be a potential hazard to migratory bird species such as the lesser scaup (Aythya affinis), the blue-winged teal (Anas discors), the mallard (Anas platyrhynochos), and the pintail (Anas acuta). These species will probably avoid the spinning blades of the generators except during poor weather conditions.

Health and Safety

The wind generator manufacturing facility and wind farm will be constructed in compliance with all federal, state, and local worker health and safety requirements. Protective equipment will be provided to mitigate noise, dust, or other potentially hazardous conditions.

Television and Radio

The rotation of the generator blades will interfere with the video channel (picture) of television. No FM or audio (sound) television interference is expected. The translator station serving Glasgow and GAFB should lie outside the region of the interference, although this is subject to verification.

Visual/Aesthetic

The visual/aesthetic acceptance of this type of facility will be determined mainly by the shape of the generators, the tower type, the spacing of towers, and the geographical location. It is suggested that a significant cross-section of Valley County residents be polled to determine the acceptability after a design if finalized and prior to production initiation.

III.5.6 Social Impacts

The implementation of a wind generator manufacturer scenario should have no significant negative social or economic impacts. The increase in employment opportunities would help to diversify the economy based primarily on the agricultural sector. Excess housing and unused educational, medical, and public service facilities at GAFB could be utilized again. The social impacts of this alternative are discussed in detail in Appendix C.

Public Acceptance

The response to survey questions concerning a wind generator manufacturing facility located in Valley County was 84 percent in favor, 7 percent against, and 9 percent unsure. Agencies, organizations, and tribes which were surveyed approved of the wind generator manufacturer re-use for Valley County. Little concern was expressed over socioeconomic impacts. A discussion of the survey methodology and the results are provided in Appendix D.

III.6 Coal Gasification

III.6.1 Introduction

One proposed re-use for GAFB is for siting a coal gasification facility. Coal gasification is a process where coal is transformed into a synthetic gas. Depending on the gasification process, the synthetic gas produced can either be high Btu (approximately 950 Btu/scf), medium Btu (approximately 300 Btu/scf), or low Btu (approximately 150 Btu/scf). The high-Btu gas is suitable for use as a substitute for natural gas but is the most expensive to manufacture per Btu. The lower Btu gases generally considered for industrial processes are less expensive per Btu to produce. Low-and medium-Btu synthetic gases are used in a process at or near the generation facility since it is not economical to ship them. Details of the coal gasification process are discussed in Section III.6.2.

In previous work, the Federal Energy Administration (FEA) contracted with MERDI (FEA 1976) to determine the feasibility of establishing an energy center at GAFB. Major factors that caused the FEA to initiate that study included the Arab oil embargo and the announcement by the Canadians that natural gas sales to the United States would be reduced over a period of time and eventually curtailed. The scope of the energy center feasibility study included consideration of coal gasification, coal liquefaction, and nuclear energy center siting at GAFB.

As was noted in the Contract Background Information section of this report, some initial emphasis was given to consideration of coal gasification as a potential re-use of GAFB. This emphasis was, at least in part, due to the recommendations that resulted from the previous FEA study. In addition, the close proximity of the base to coal and water resources provided motivation to consider siting such a facility at GAFB in this project. Two other factors that were considered of value at GAFB for use in connection with siting a coal gasification facility were the potential for use of existing facilities, i.e., large buildings, cement ramps, etc., and the existence of housing and other support facilities to service a large influx of people that would be needed to construct and operate the facility.

Three schemes were considered for a re-use of GAFB in conjunction with coal gasification. Where it was suitable, the viability of each scheme was evaluated from a technical, economic, legal, environmental, and sociological perspective.

None of the three approaches taken in this report resulted in a recommended re-use of GAFB in conjunction with a coal gasification plant. The essential reason for this conclusion is that of the schemes considered none demonstrates that there are economic advantages to doing so.

One of the three re-uses considered is a plan for using the existing residential community support facilities at GAFB to house a temporary construction work force while a gasification plant (or some other large facility) was being built. The plan involved transporting the workers by air from a remote site to the base on a daily basis. A first-order economic analysis of this plan resulted in the conclusion that costs associated with doing this compared to costs associated with building a temporary construction camp at the plant site were about the same. For the construction work force, though, there are some non-economic value judgment issues such as the quality of housing and support facilities that might make GAFB attractive for such a re-use. It is suggested here that if plans materialize for construction of large facilities in the region around GAFB, then further consideration of such a plan for the specific application should be evaluated.

Economic Analysis Findings

A brief discussion of coal gasification economics is deemed suitable for presentation at this point because our analysis results indicate the following. High-Btu synthetic gas (SNG) produced from coal by gasification processes currently thought to be technically viable is not competitively priced with substitute fuels, nor is it expected to be for about 15 years. The essential reasons for these findings are the huge capital and operating costs of the high-Btu gasification plants. It should also be noted that there currently are no commercial high-Btu coal gasification plants in operation or under construction in the United States. The cost estimates derived in this report for SNG production have been based on proposed designs, and the actual costs for producing SNG are not known and are subject to speculation. Until a facility is constructed and operated, the actual cost figures will not be known.

Two factors provide much of the basis for current interest in coal gasification. First, research activities in this area have been renewed over the past several years, and the potential for someone to devise a new, less expensive method to manufacture synthetic high-Btu gas exists. The second is that natural gas supplies are finite; and as they are depleted, their costs will rise. Therefore, if it is assumed that we will continue to demand substantial amounts of energy supplies in the form of gas, at some date in the future high-priced SNG will become competitive with natural gas. Also, the curtailment of natural gas supplies by a supplier such as the Canadians also could provide some motivation for the United States to have the capability to produce large amounts of SNG to provide essential services such as residential space heating almost regardless of fuel costs.

It is worthwhile to note that the Montana Power Company, in a report to the Montana Public Service Commission published on May 30, 1978, has shown that they anticipated meeting 20 percent of their gas demand in 1990 by a supply resulting from a mix of gasified coal and new discoveries from natural gas fields in Montana and Wyoming. The fraction of gas that was to result from these sources would increase to about 50 percent of Montana Power Company gas supplies from all of their sources by the year 2000. Depending on the extent that the new discoveries in Montana and Wyoming materialize, the economic viability of coal gasification to produce SNG might become attractive during that period.

The economic discussions were presented to provide some insight into the rationale for MERDI attempting to determine what type of coal gasification scheme, if any, might pose a re-use for GAFB facilities. Also, there is a question of when such a use would be viable. That is, if coal gasification to produce high-Btu synthetic gas is not economical or useful now, when would it be and to what extent could GAFB facilities be utilized?

In concluding this discussion, it should be noted that production of low- and medium-Btu synthetic gas (150 and 300 Btu/scf, respectively) for industrial applications does appear to have some promise in the near term. Primarily, there are two reasons for this finding. First, industrial users of natural gas are often times sold interruptible supplies by the utilities. Hence, when residential use peaks, these customers received reduced or curtailed service. This practice can sometimes result in significant economic losses for the industries affected. Thus, an assured supply of gas, even at premium price, might be found suitable to some of these industrial users. Secondly, the production of low- and medium-Btu synthetic gas requires much less capital, is thermally more efficient, and the overall cost is significantly less per Btu than it is for high-Btu synthetic gas. Given these factors, the low- and medium-Btu synthetic gas could be an economical and viable substitute for new industries that could locate near mine sites. Viability of this approach and determination of a suitable location for an industry involves a relationship between relative transportation costs of raw materials, products to market, and coal. This option was not treated in this report since it was beyond the scope of work of defining feasible re-uses for GAFB.

III.6.2 Process and Plant Description

Introduction

Several process and plant descriptions that are suitable for the production of synthetic gas from Montana lignite coals, such as those located in the vicinity of GAFB, have been defined in the literature. A report published by the DRAVO Corporation in 1976 for the Montana Trade Commission (MTC) provides a survey of schemes potentially suitable for coal gasification in Montana. Some of the plants discussed in the report are commercially producing synthetic gas from coal in various parts of the world. Of those different processes researched, the one envisioned for the GAFB facility is designated as the Lurgi process (see process selection rationale, Appendix E, Section 1). The Lurgi coal gasification plant proposed would utilize 25,000 tons of lignite coal per day and would produce process electricity and steam, 150 mmscfd of SNG, plus 1,000 tons per day of anhydrous ammonia. The gas would be transferred to the existing natural gas distribution system, the ammonia would be utilized as a fertilizer feedstock with part of the product being marketed in Montana, and the resultant surplus supplies would be sold to markets outside of the state.

Background

Commercial artificial gas production was first initiated in the United States in about 1816, and by the early 1900's, nearly every population center along the east coast had a municipal gas plant. Typically, bituminous grade coal was burned in an oxygen-deficient atmosphere in the presence of steam to yield carbon monoxide and hydrogen. Often the gas was carburetted with fuel oil, which was chemically "cracked" to produce CH_4 and hydrogen (Conn 1973). The plants operated at atmospheric pressure, and the minimal attempts at soot and hydrogen sulfide removal made the process a dirty one. The product gas had a heating value of between 300 and 500 Btu per standard cubic foot (scf). The discovery of large natural gas reserves in the period 1910 to 1925, with their associated low production cost and high heating value (e.g., Btu/scf), led to the development of extensive gas distribution systems. Clean-burning natural gas quickly became the preferred residential (heating and lighting) and industrial fuel; the municipal "gashouse" facilities thus disappeared gradually, becoming rarities by the late 1930's.

The Lurgi dry-ash, fixed-bed process (MTC 1976) is the culmination of efforts initiated in Frankfurt, West Germany about 40 years ago and appears to be most viable of the gasification processes reviewed. Since that time, more than 58 units have been built in Europe and elsewhere (except the United States); the largest installation is comprised of 13 gasifiers at the Sasol synthesis plant in Sasolburg, South Africa.

Only in recent years has the cost of the natural product been sufficiently high to revitalize the notion of SNG; however, the technologies required for pipeline quality gas production would have to be far more sophisticated than those ever used previously.

The Lurgi plant proposed for location at GAFB would be self-supporting; it would include all necessary process systems, pollution control facilities, tankage, and other physical support, including steam/electric power generation utilities. The design discussed below is based on commercially proven process equipment and a history of actual performance of Lurgi-designed plants. It will achieve an overall service factor of at least 92 percent annually (MTC 1976).

In this process, coal is contacted counter-currently with a steam-oxygen mixture to produce a crude gasifier product of raw gas, steam, tars, ammonia, and sulfur compounds. Further processing via shift conversion, rectisol gas purification, methane synthesis, CO_2 removal, and phenosolvan gas/liquid purification steps yield high-Btu, pipeline-quality SNG. In addition to the synthetic gas, other potentially marketable products include tar, tar oils, naphtha, ammonia, phenols, and elemental sulfur.

Process Description

A simplified overview of the proposed Lurgi coal gasification process and ammonia production is shown as a block diagram in Figure 18. The process depicted in this figure generally flows from left to right, with the arrows indicating the direction of product flow from one process step to another. A discussion of the process flow shown in the figure is provided below.

Processed coal, oxygen, and steam are fed into the gasifiers at the gasification plant. In the gasification plant, the volatile matter in the coal under the presence of heat, pressure, and steam will react to give off a crude gas that will be further processed into ammonia, SNG, and other by-products. The char remaining from the coal after the volatiles have been removed is combusted and reduced to ash. The heat given off during combustion of the char is used in driving the gasification process. The hot crude gas leaving the gasification plant enters a gas cleaning and quench process plant where much of the heavy hydrocarbons, i.e., tars, oils, and dust, are removed for further processing. These heavier hydrocarbons are further processed to yield some useful by-products.

In the first step taken to process these heavy hydrocarbons, the tars and oils are separated from the product stream in the gas liquor separation plant. The product remaining after the tar oil is removed is then sent to the phenosolvan recovery unit. In the phenosolvan recovery unit, crude phenol and dephenolized liquids are produced. The crude phenol, a marketable by-product, is stored in a suitable storage tank while the dephenolized liquids are further processed in a Chemie-Linz Lurgi process to produce anhydrous ammonia. The anhydrous ammonia is condensed to a liquid form for storage with the anhydrous ammonia produced in the ammonia synthesis leg of the coal gasification process.

Crude gas from the gas cleaning and quench plant is divided between the SNG production and ammonia production legs of the gasification process. About 60 percent of the crude gas is fed to a shift conversion process, while the remaining crude is routed directly to the SNG gas cooling unit.

In the shift conversion process, the crude gas's composition is altered under the presence of heat, pressure, and steam to produce a gas that is suitable for efficient SNG production and ammonia synthesis. The converted gas from here is then further split into two unequal streams. The stream with the larger fraction of gas is directed to the SNG leg of the process, while the lesser gas stream passes to the ammonia synthesis leg.

The first step in the production of synthesis ammonia after the shift conversion involves the cooling of the gas to remove remaining heavier hydrocarbons and unheated steam before the gas is purified at low temperature in the rectisol unit. The rectisol unit is designed to remove sulfur, carbon dioxide, and other impurities from the stream before it is processed in the nitrogen wash unit. The product leaving the nitrogen wash unit has been

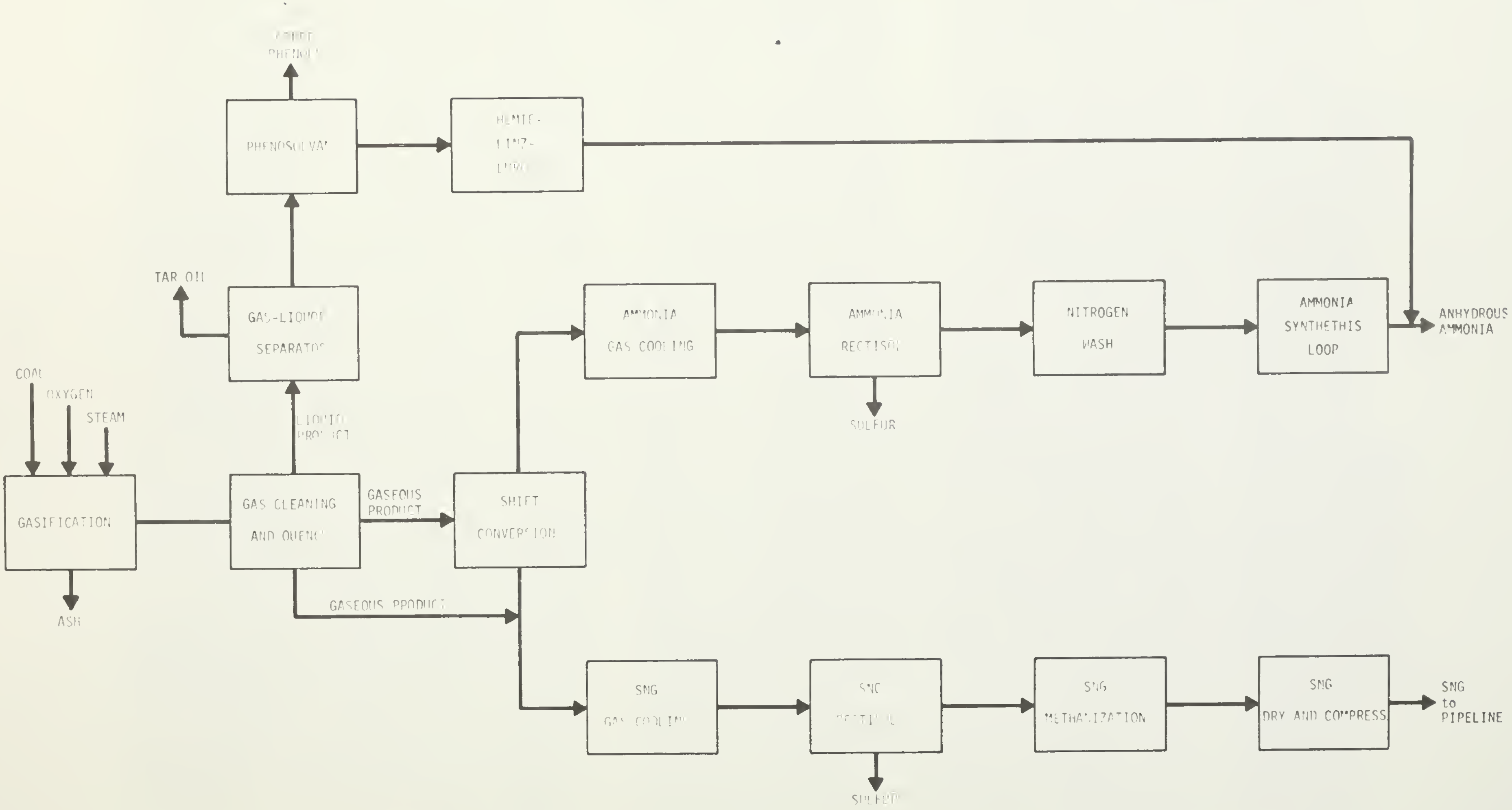


Figure 18.--Lurgi Coal Gasification Process Simplified Flow Diagram

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cooled until all products except nitrogen and hydrogen are condensed. The remaining hydrogen and nitrogen gases are then mixed in the correct proportions for introduction into the ammonia synthesis loop. In this final process step, the gases under the influence of pressure and heat are converted to anhydrous ammonia and then cooled. The resultant liquid anhydrous ammonia is sent to storage tanks.

The larger fraction of product that resulted from the shift conversion process is mixed with the 40 percent of crude gas leaving the gas quench and cooling plant. This mixed stream is then cooled to remove heavier hydrocarbons and untreated steam before low-temperature purification in the rectisol unit in the SNG leg of the process. In the methanization unit, the product is converted from a low-Btu synthetic gas to a methane-rich, high-Btu synthetic gas. The product is then dried to remove excess water and compressed to be put in storage or introduced into a pipeline for distribution.

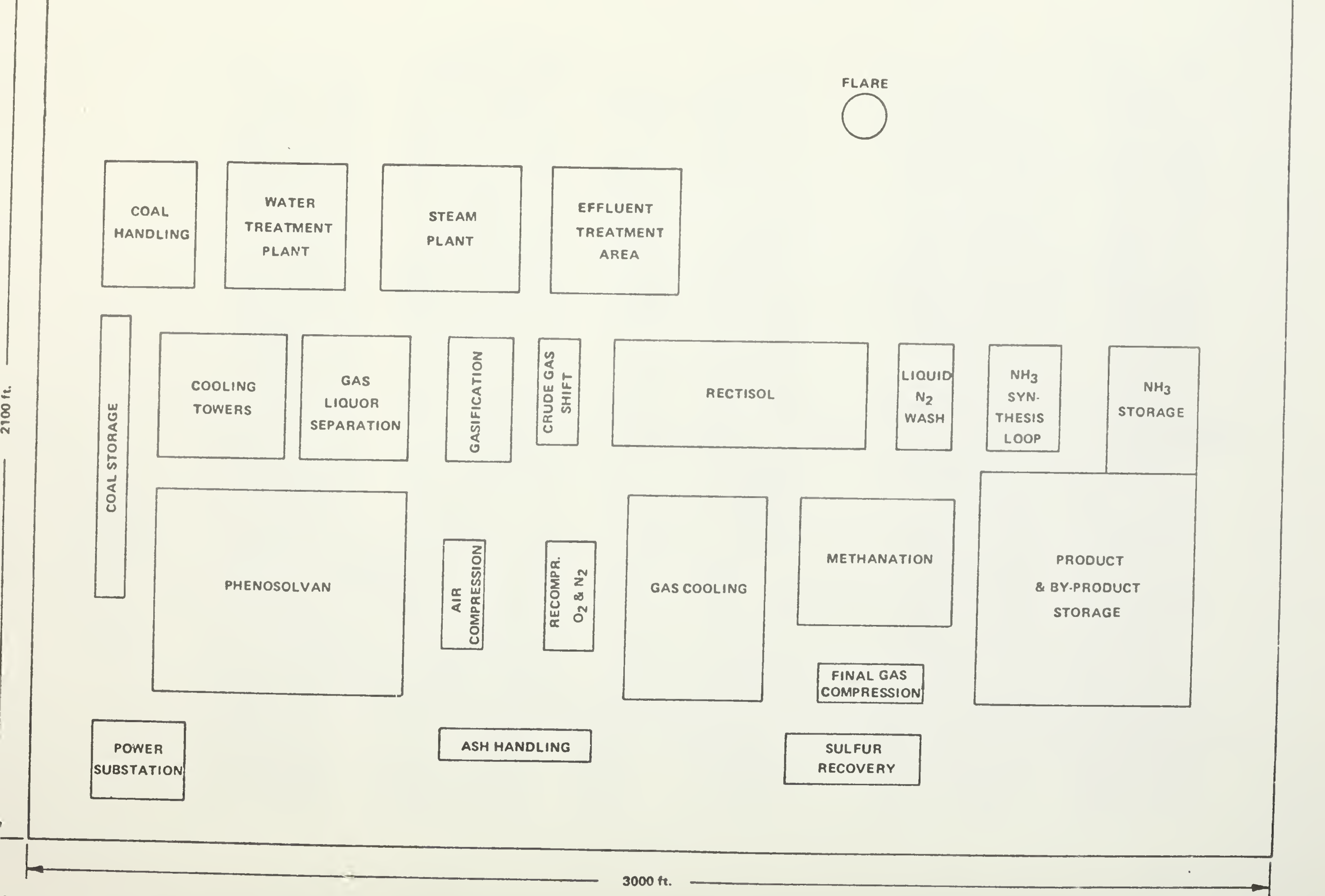
Plant Description

A brief description of the plant layout is offered to provide the reader with some idea of the physical relationships of the process units previously described. Figure 19 shows a schematic representation of the proposed Lurgi coal gasification plant layout. A detailed discussion of the proposed plant layout is not provided, and the reader is referred to the process text for explanation of the components shown in this figure.

Note that in addition to the process plants discussed earlier, other support facilities such as coal handling, power substation, steam plant, effluent treatment, cooling towers, etc. are required for plant operations.

The space requirements and relative portions of the process units and associated facilities are clearly depicted in Figure 19. The overall plant area requirement is about 150 acres. It is important to note that not only does the proposed gasification plant require substantial land area, but the various process plants are composed of uniquely designed hardware and structures which must be placed in the correct relationships to one another. Other components of this gasification facility include coal dead storage, sediment ponds, trackage, and pools, etc., all of which comprise the complete gasification facility.

In the process description discussed earlier, only the primary product process flows were described. In the actual plant, there are many secondary processes that make correct placement of the various process plants crucial for efficient overall plant operations. This also necessitates a complex arrangement of pipes, valves, tanks, etc. to ensure that these products can be fed from one process to another at the correct temperature, pressure, and flow rate.



Source: Montana International Trade Commission - Coal Gasification Feasibility Study

Figure 19.--Overall Plant Layout and Space Requirements

These discussions are offered to support the argument that there does not appear to be much, if any, potential re-use of current base facilities for use in assembly of the proposed coal gasification plant. In fact, there appears to be a net capital deficit in siting a coal gasification plant at GAFB since it probably would be necessary to dismantle some of the existing structures on the base to make room for the proposed coal gasification process plants and support facilities.

III.6.3 Economic Analysis

Introduction

An economic analysis was made to evaluate the cost of and market for producing SNG in the GAFB vicinity. The costs of financing, constructing, and operating a large coal gasification plant that has a 150 million scf SNG output and a 1,000 ton per day anhydrous ammonia output were used in calculating the SNG price. In the market analysis, the projected costs of producing SNG were compared against the current and projected costs of two substitute fuels, natural gas and electricity. In addition, an economic evaluation was made to determine the costs of housing a construction work force at GAFB and transporting them to the proposed plant construction site. This appraoch identifies a potential re-use of GAFB in conjunction with a remotely sited facility and also serves as a model to indicate if such a re-use of the GAFB facilities could be considered for projects of similar scale. The transportation plan costs were compared to costs of building a temporary construction worker living complex at the plant site. The methodology and analysis for determining costs for the proposed options are discussed below. Also included is a description of the work force that would be employed to operate and maintain the proposed coal gasification plant.

From the above analysis, two findings become apparent. First, there does not appear to be a viable market for high-Btu synthetic gas in Montana now, nor does it look like one will exist in the near future, given the cost and availability of competitive fuels. Secondly, if a market for SNG does materialize in the future, there would be additional costs associated with operating a coal gasification plant at GAFB rather than the mine site. The results of this analysis indicates that coal gasification at GAFB is not a suitable re-use for the base facilities.

Plant Construction and Operation Cost

The projected costs for construction of the large gasification plant proposed for consideration in this report were based on estimates made by the Lummus Corporation (MTC 1976). The costs presented in the Lummus report were adjusted by the Andy-Whitman Public Utilities price index to reflect 1978 prices for presentation in this report.

It is important to note that the coal gasification plant cost estimates reported on in the Lummus report were qualified as being "an order of magnitude estimate" and that an accurate assessment of the actual costs could only result from completing a formal design of the proposed plant. A similar qualifier would hold for the estimates of plant construction and operation costs derived in this report. The results of our analysis indicate that the total capital required for the coal gasification plant proposed is 615.3 million dollars.

In Table 12, the total capital required to construct the coal gasification plant is listed. Also shown in the table is a gas cost estimate which was made by considering the coal costs, operating costs, by-product credits, and capital costs. A detailed breakdown of capital costs by major plant component is listed in Section 1 of Appendix E.

The following assumptions about the financial structure of the investor were utilized in developing the SNG costs presented:

1. 1978 dollars;
2. 52 percent corporate income tax--includes federal and state;
3. seven percent investment tax credit;
4. double declining balance for depreciation;
5. property taxes and insurance at 3 1/2 percent of investment;
6. 13.2 percent return on investment for utility company;
7. 3 1/2 to 4-year construction period;
8. 20-year tax life; and
9. 25-year book life.

All of the costs and capital investments were examined under the assumption that current technology is used and that all plants are new. It also was assumed that no additional development costs are incurred.

The following assumptions were made regarding the variable costs facing investors:

1. coal is initially purchased at $7.50 per ton delivered at the plant (ERDA/AGA 1976) with a two percent annual coal price increase;
2. other variable costs increase at five percent per year;

3. Montana lignite A coal is utilized with a heat value of 15.6 million Btu per ton; and

4. thermal efficiency (measure of the heat value of gas produced compared to that of the coal consumed in the conversion process) of 0.60.

The projected SNG price shown in Table 12 is the first year's operation. To market SNG at this price, it would be necessary that the cost of alternate fuels, electricity, or natural gas be equivalent in price or that these forms of energy be unavailable. In this discussion, it will be assumed that the availability of alternate fuels is reflected in their price. That is, as alternate fuels become scarce, their price goes up. The current and projected residential effective fuel costs for SNG, electricity, and natural gas from 1978 to 2000 are shown in Figure 20. The costs for electricity and natural gas were obtained from a report by the Montana Power Company to the Montana Public service Commission dated May 30, 1978.

The costs shown for SNG were obtained from those calculated using the Lurgi plant proposed for consideration at GAFB. Note that the SNG and natural gas prices have been adjusted by a factor of 60 percent to account for heating system inefficiencies. This adjustment was made so that direct comparisons between the effective fuel costs for heating with electricity or gas fuels could be made.

From Figure 20, it is apparent the projected SNG becomes competitive with the projected costs of electricity in about 1980 and with natural gas in about 1988.

Some cautions in interpreting these results are in order though. First, these projected SNG costs are based on a conceptual design of a proposed Lurgi coal gasification process, and the cost estimates used are preliminary in nature. It is felt that the cost estimates shown in Figure 20 for SNG represent a lower bound and that actual costs will depend on a multitude of factors that cannot be accurately predicted without a complete engineering design of a plant, definition of land costs, community development costs, contracted coal costs, actual interest rates, etc. For example, if the fixed and variable costs associated with this plant and process increased by 25 percent (not an unrealistic number), the projected SNG price versus time curve would look like that shown in Figure 21. In this calculation, the competitive pricing between SNG and electricity does not occur until about 1982, and the price of SNG relative to natural gas does not converge for the projections shown. Secondly, the projected electricity and natural gas prices are subject to change, and if the anticipated costs for these energy sources do not increase at the projected rates, then the market of SNG would not develop as discussed earlier.

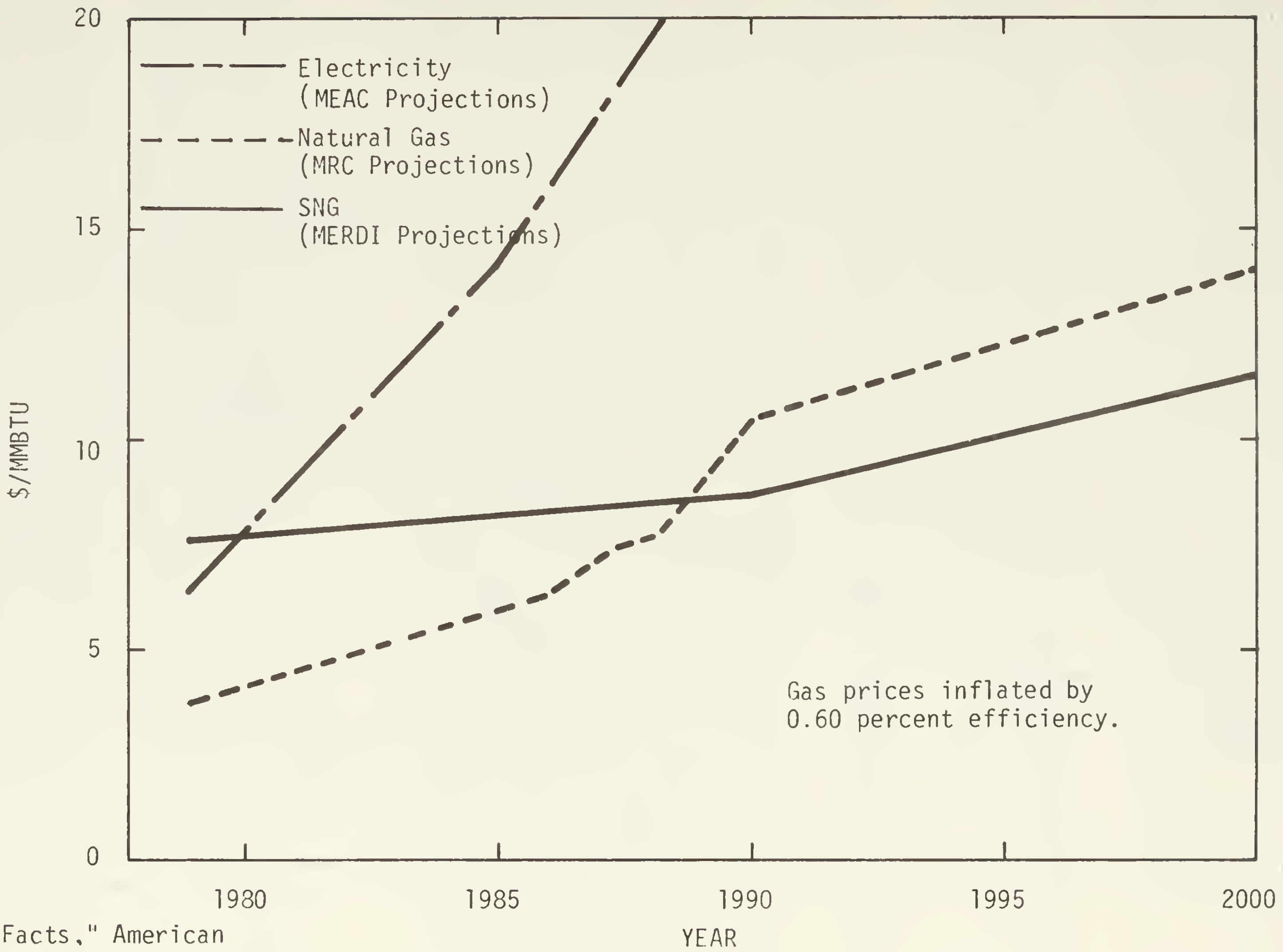
Caution must also be excercised in using these proposed cost estimates presented in Figures 20 and 21. It is important that the reader understand the assumptions and the approximate nature of cost estimates that were

Table 12.--Total Capital Required for Coal Gasification Plant

Plant Construction Costs	MM $/year
Total Capital Costs (includes contingency, general and administrative and engineering supervisor)	$565.0
Start-up Costs	28.3
Total Capital Required	$593.3
Working Capital	22.0
TOTAL CAPITAL REQUIRED[1]	$615.3

		MM $/year	$/MMBTU
Gas Cost Estimate			
Coal Costs		$ 61.6	1.25
Operating Costs:			
Catalyst and Chemicals	3.3		
Purchased Utilities	3.6		
Labor:			
Direct Operating	4.2		
Maintenance	8.5		
Supervision	1.9		
General & Administrative Overhead	8.9		
Supplies:	9.7		
TOTAL		$ 40.1	0.86
By-Product Credit: (Ammonia, Sulfur, Tar Oil, Phenols)		($ 32.8)	(0.70)
Capital Costs:			
Local Taxes and Insurance			
Depreciation			
Average Returns			
Average Federal Income Tax			
TOTAL		$148.7	$3.17
TOTAL REVENUE REQUIREMENT		$217.6	$4.65

[1] Although the costs associated with pollution control equipment were not included in these costs, it is recognized that they would add significant costs by the initial capital required for plant construction. They were not added because of a lack of data about specific pollution control systems and their costs.



Source: "Gas Facts," American Gas Association, U.S. Bureau of Labor Statistics, Montana Power Company.

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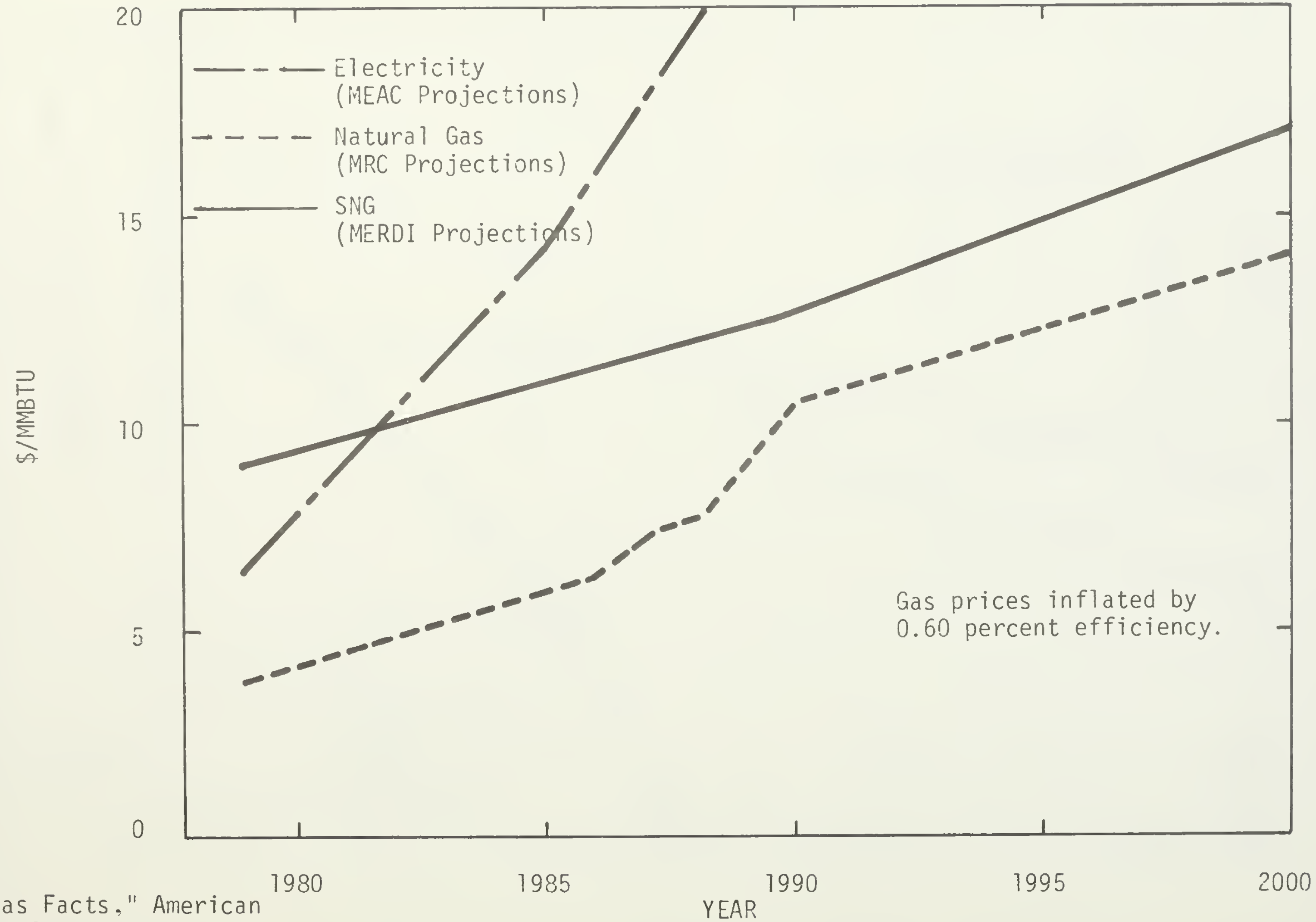
Figure 20.--Residential Effective Fuel Costs



Gas prices inflated by 0.60 percent efficiency.

Source: "Gas Facts," American Gas Association, U.S. Bureau of Labor Statistics, Montana Power Company.

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Figure 21.--Residential Effective Fuel Costs
(SNG plant operational and capital costs inflated by 25%)

used in this analysis. These figures were provided to indicate only the trends in fuel cost data and to show that a potential for soluble SNG does exist in the future based on substitute fuel costs and availability. It should also be recognized that the costs of heating fuels to the customer include capital costs associated with the heating system hardware. If a person chose to use electricity rather than gas for space heating, his initial capital expenses would most likely be less. This additional cost associated with the gas heating system would make it less economically attractive at least initially.

Then one must recognize that about two thirds of Montana Power's energy demands are for natural gas and that converting substantial amounts of this land to electric power requirements would result in significant capital costs at the generation end for the distribution system and at the use end. The transitions would be very difficult to accomplish.

Table 13 is a listing of a few proposed high-Btu coal gasification projects. This table serves to show the status of commercial coal gasification projects to date and the relative capital cost per SNG production for each facility listed.

The Lurgi plant proposed in the MTC study has the lowest capital investment per unit of SNG output for any of those shown. Note that all but the MTC plant and the American Natural Resources Company plant are designed for an output of 250 MM scfd or greater. It should also be noted that the American Natural Resources Company plant is similarly sized to the MTC plant and that the capital per unit SNG output is considerably higher than any of the other plants shown. On a capital investment basis, the MTC plant has the lowest capital cost per SNG production of any of the plants shown. The implication of this is that if the similar relationships for fuel and operating costs hold true for other plants, then the gas produced in the MTC plant will have the lowest calculated cost assuming that financing, taxes, etc. are similarly determined for each plant. Even at this lower cost, SNG was not projected to be an economical substitute for natural gas until at least 1988.

Plant Siting Schemes

The objective of this discussion is to evaluate the economic considerations of siting the proposed Lurgi coal gasification facility at GAFB. For reasons that will be made clear below, three different schemes for siting a coal gasification plant are discussed, and the most feasible of those plans do not pose any significant economic rationale for re-use of GAFB in conjunction with a coal gasification plant for production of SNG.

The first scheme considered for siting a coal gasification facility at GAFB was to put the gasification plant on the base and develop a mine adjacent to that facility. Close proximity of a coal mine and gasification plant would result in low coal handling costs. This plan was determined not to be feasible at the onset since known coal reserves in Valley County could not be mined economically on a commercial scale to provide fuels for the proposed plant.

Table 13.--Proposed High BTU Coal Gasification Projects

Sponsors	Location	Output (MM scf)	Process	Project Cost	Project Cost Output (MM scf/day
WESCO, Texas Eastern Transmissions Corp, & Pacific Lighting Corp.	Navajo reservation, Four Corners area, N.M.	250 (1 plant) with expansion to 2 plants	Lurgi gasification witn methanation	1.067 billion	\$4.3 million / MM scf/day
American Natural Resources Co., Peoples Gas Co., Columbia Gas System, Inc. Tenneco, Inc., and Transco Cos.	Mercer County, N.D.	125 (1 train) with expansion to 2 trains	Lurgi gasification with methanation	\$900 million (second phase \$1+ billion)	\$7.2 million / MM scf/day
Natural Gas Pipeline Co of America	Dunn County, N.D.	275	Lurgi gasification with methanation	\$1.3 billion	\$4.7 million / MM scf/day
El Paso Natural Gas Co	Navajo reservation Four Corners area, N.M.	288	Lurgi gasification with methanation	\$1.225 billion	\$4.2 million / MM scf/day
Panhandle Eastern Pipe Line Co. (Operator, Peabody Coal Co.)	Eastern Wyoming	270	Lurgi gasification with methanation	\$1.3 billion	\$4.3 million / MM scf/day
Montana Trade Commission Study	Northeastern Montana	168*	Lurgi gasification with methanation	\$615 million	\$3.7 million / MM scf/day

*Plant was designed for output of 150 MMSCF of SNG and 1,000 TPD of anhydrous ammonia. To compare the Montana Trade Commission plant with the others listed in the table, the anhydrous ammonia was converted to equivalent SNG units of production.

The second approach taken was to locate a coal gasification plant at GAFB and consider transporting coal from a nearby source such as the coal fields located south of the base in McCone County near Circle, Montana. This plan would involve transporting the coal from the mine site to the proposed facility at GAFB. The haul distance from any known suitable coal reserve would be about 120 miles. Consideration of this approach resulted in the following findings.

1) The amounts of coal needed for the proposed gasification facility are quite large (approximately 25,000 tons/day), and there would be significant costs associated with handling and transporting the coal from the mine site to GAFB. For example, a dollar per ton handling cost would result in an additional annual plant operation cost of 7.3 million dollars. Additional plant operation costs over a 20-year period would be $146 million. These costs would be added to costs for trackage and automated handling and unloading facilities for the coal transport system. To economically justify a scheme where this approach would be taken, significant capital savings associated with siting the coal gasification plant at GAFB must be obtained. This capital savings would be in the form of support facilities such as housing, storage buildings, offices, etc.

2) The coal gasification plant is a very specialized facility comprised of many unique structures and hardware that must be configured in a specific arrangement. Hence, only a limited number of existing structures on the base would be of any value to the plant. These useful structures would basically be comprised of warehouse-type buildings (hangers) for storage of materials and supplies, office buildings, housing, and community support buildings (i.e., schools, medical, etc.). Although these facilities represent a significant cost to the proposed coal gasification plant and associated community, their total value would likely be significantly less than the additional $146 million associated with handling the coal.

   It should also be noted that the proposed coal gasification complex requires about 150 acres of land with additional area (at least 150 acres) required for coal storage, sediment ponds, trackage, ash pools, etc. A review of the available land area indicates that there is not enough open area on the base to site the plant without moving existing structures.

   Also, placement of the plant on the most suitable base property would essentially leave no buffer between it and the housing area. Concentration of various contaminants that would result from the gasification process that are close to a residential area might exceed those values legally acceptable for residential areas.

3) Finally, siting of the coal gasification plant at GAFB would be an unlikely option if the Fort Peck Indian Reservation obtains a Class I air quality rating. This might very well become an economic constraint given the scheduling delays that could occur over litigation to resolve problems of siting the plant there.

As can be seen from the above discussions, there are no apparent capital advantages to siting the coal gasification facility at GAFB. Locating a coal gasification facility at the mine site in McCone County would alleviate those problems listed above but would require the establishment of a temporary town to house approximately 2,500 workers adjacent to the proposed facility during part of the four-year gasification plant construction period.

This approach, though, does not pose any re-use for the GAFB facility. Therefore, a third approach was considered to determine if GAFB had a potential re-use in conjunction with a coal gasification facility in the area. Three modes of travel were examined for potential use as connecting links between existing housing at GAFB and the construction site near Circle. Four options for temporary housing at the construction site were examined.

Housing cost at the site, except for single-family homes, was based on the experience of Colstrip electric plants #1 and #2 in the early 1970's. All single-family housing at Colstrip was intended to house the permanent work force after use by construction workers; hence, it was larger and more expensive than would be practical for temporary use.

Results of the study indicate that the major determinant of cost-effectiveness of the on-base option is the need to pay construction workers travel time. The least expensive transport solution (bus on highway) requires nearly 4 1/2 hours per day of travel for each worker. Acceptance of such a time penalty without pay is unlikely. If as much as straight-time pay is required, air travel is the least expensive mode. However, with very specific and limited exceptions, on-base housing plus air transport is not competitive with on-site housing.

The more important of these exceptions is that of on-base family housing as an alternative to on-site bachelor camps. Additional cost of on-base family housing is less than $2,000 per worker per year provided that the workers do not require payment for travel time. Experience at Colstrip indicates that many married workers lived in bachelor camps at the site during the work week, then commuted long distances to be with their families on the weekends. If workers are willing to travel without pay for travel time in return for the opportunity to be with families every night and if the costs up to $2,000 per worker can provide a more stable and productive workforce, then this option should be examined in more detail. Details of this analysis which delineate site and support improvement costs are found in Appendix E, Section 1.

Justification for siting or not siting a coal gasification plant at GAFB was based, for the most part, on an economic analysis. Another consideration for siting the facility at GAFB and which is not readily quantifiable is the socioeconomic aspects that a large influx of people, 700 permanent workers and families, will have on the small community. For example, Circle, Montana has about 960 people (1970 census), and the proposed coal gasification plant if built in Circle would engulf that populace. This may or may not be acceptable to the local residents, and depending upon the measures taken by the local residents, if an investor wanted to site a large mine mouth facility there, he might find himself involved in some very complicated and costly legal delays. A good example of this is demonstrated by the delays that have occurred for construction of Colstrip #3 and #4. The point being that although there might be significant costs associated with transporting coal from a mine, possibly at Circle, to GAFB it might be the less expensive and the less time consuming approach to take rather than try to site a major facility near Circle.

It should also be pointed out that although siting the coal gasification facility on the base properties is not a recommended approach to take, there does exist some federal and state lands adjacent to the base which are suitable for siting such a facility. This approach would allow for some use of the base facility for warehousing and offices and to house the bulk of the plant operation and community. The main problem with this approach would be the attainment of a Class I air quality designation on the Fort Peck Indian reservation east of the base properties. Without major changes in the emissions from the coal gasification plant, it would not meet the emissions criteria set by those standards.

An arrangement for housing a construction work force at the GAFB facilities might preclude some undesirable socioeconomic impact conditions for small towns like Circle, Montana. That is, as energy resources are developed in northwestern Montana, the base could act as a center of operations for various large companies, hence lowering the impact of construction camp-type towns on small eastern Montana communities. Although such an approach might result in directly increasing construction costs, it might be effective in decreasing indirect costs due to construction delays brought on by the smaller communities interested in maintaining their stability.

Employment

During the four-year construction of the plant, it is anticipated that employment levels will be about 1,200 for the first year, 2,100 to 2,500 for the second and part of the third, 1,000 for the following year, and about 350 during the final one-half year of construction. A breakdown of construction work force personnel is not provided here. Their wages are included in the plant construction costs discussed earlier. A breakdown of the anticipated labor requirements and payroll during the operation of the facility are shown in Table 14. This table shows that a total of 710 personnel will be required to maintain and operate the proposed plant.

Table 14.--Personnel Requirements and Salaries

	No. of Personnel	Total Annual Salary
Operations and Administration		
Plant Manager	1	$ 47,500
Assistant Plant Manager	1	37,200
Superintendents	3	101,700
Supervisors	50	1,299,500
Engineers	34	768,400
Foremen	6	111,870
Operators, Lab Technicians	250	3,413,000
Clerical	33	335,610
SUBTOTAL		$6,114,780
Add 30 percent for overhead		1,834,434
TOTAL		$7,949,214
Maintenance		
Superintendent	1	$ 33,900
Supervisors	9	233,910
Engineers	9	203,400
Foremen	32	496,640
Craftsmen, Helpers, Laborers	275	4,101,900
Clerical	6	61,020
SUBTOTAL		$5,230,770
Add 30 percent for overhead		1,569,231
TOTAL		$6,800,000

III.6.4 Legal Requirements

Overview

A coal gasification facility will require extensive review by a number of state and perhaps federal agencies. A Certificate of Environmental Compatability and Public Need must be obtained from the Board of Natural Resources and Conservation. The coal handling and gasification process will require air and water pollution permits from the Department of Health and Environmental Sciences and perhaps from the Environmental Protection Agency. The Department of Health also must approve solid waste disposal plans. Indoor emissions, noise levels, and worker safety provisions must meet state and federal standards.

To provide the large volumes of water necessary, a Water Use Permit must be obtained from the Department of Natural Resources. Off-site land disturbances associated with water diversion, impoundment, and pipeline construction, rail spur extensions, utility lines, and other facilities to provide necessary water, power, and utility service to the plants will be reviewed by a variety of state, federal, and local authorities.

Finally, fertilizer produced by the plant must be registered with the Montana Department of Agriculture.

Summary of Applicable Permits and Acts (also see Appendix B)

1. Major Facility Siting Act: Certification required.
2. Air Pollution Permits: Coal preparation and gasification process will require review.
3. Water Pollution Permits: Gasification process will require review.
4. Solid Waste: Disposal of slag and ash at the mine site requires approval. Disposal elsewhere requires review.
5. Hazardous Waste: Review required.
6. Occupational Safety and Health: Indoor emissions, noise levels, and safety provisions must meet standards.
7. Water Supply: Water Use Permit required for expanded supply.
8. Power Supply: If new supply is required, certification under the Siting Act may be necessary.
9. Off-Site Activities: Water diversion, pipelines, power lines, utility lines, etc.
10. Miscellaneous: Fertilizer registration.

A detailed discussion of applicable permits and acts is found in Appendix E, Section 2.

III.6.5 Potential Environmental Impacts

Introduction

The development of a Lurgi gasification plant as a re-use of GAFB may result in a variety of environmental impacts. Technical and scientific details of these impacts, in addition to discussion of impacts arising from a hypothetical coal mine, are included in Section 3 of Appendix E. Many of the gasification-related impacts are significantly adverse to the surrounding Valley County natural environment. The environmental impact potentials were evaluated in regard to ten aspects: climate and air quality, noise levels, water quantity and quality, solid waste generation, land use, soil, vegetation, wildlife, rare and endangered species, and health and safety. The potential impact in each of these areas is delineated in the following paragraphs. Details of these assessments are included in Appendix C.

Climate and Air Quality

Changes in microclimatic conditions (localized climate patterns) may result from thermal and carbon dioxide emissions that arise from the plant's heat exchangers, flue gases, and cooling towers. These changes include increased moisture in the air, trapped hot air, and cloud and ice formation on cold mornings. Local icing and reduced visibility could impair the use of the GAFB runways, particularly for aircraft without instrumentation. Expected sources of air pollution include dust, smoke, and vehicle fumes produced during the construction of the plant. Gas and particulate emissions from the burning of coal fines (small particles of coal) in the steam plant and the Lurgi gasifiers, in addition to periodic releases of gas from the emergency flare-off system, will be produced during the operation of the plant. The major gases are sulfur dioxide, nitrogen oxides, and hydrocarbons. Agricultural crops and range livestock within several miles of the plant will be fumigated by these noxious gases. The rapid release of sulfur dioxide during emergency flare-off could produce levels of pollution that exceed fereral air quality standards. Suspended particulate matter in the air will reduce GAFB visibility.

Noise

Noise levels may approach 65 dBa at the Lurgi plant's boundaries during construction and development. The levels should decrease to 50 dBa during the operational phase. Fifty dBa is about the same level as the noise generated during a busy day in the downtown area of the city of Glasgow. Higher noise levels (80 to 100 dBa) may be associated with specific phases of plant operation. Protective ear plugs may be required for workers near the source of the noise.

Water Quantity and Quality

Adverse impacts to surface and possible groundwater systems are a major concern during both the construction and the operation of the plant. Water requirements include boiler feed, heat exchange in cooling towers, and heat removal in quenching tanks. Up to 9,800 acre feet of water per year will be utilized in the gasification process. This will require larger diameter piping and higher capacity pumps than presently exist to deliver water from the Fort Peck Reservoir to GAFB. A surface diversion reservoir located on the Missouri River may be required to ensure a supply of sediment-free water to the plant. Implementation of this diversion would cause slight changes in downstream siltation. Between one to two acres of riverside vegetation would be permanently eliminated by the reservoir. An alternative to this approach is to construct a settling or holding reservoir near the plant's Water Treatment Facility. The wastewater effluent discharge from the plant will be composed of domestic sewage, used process water, and chemicals including ammonia, phenols, acids, solids, and sulphates, and must be treated in the Lurgi Waste Water Treatment Facility in order to avoid rapid degradation of surface water or groundwater aquifiers. The accidental release of plant effluents from the plant's waste holding ponds could result in the contamination of Porcupine Creek and possibly the Milk River.

Solid Waste

The estimated solid waste generation from the Lurgi plant and the associated ammonia facility is 1,267 dry tons of ash and slag per day. The construction of a large pond (approximately 349 acres x 20 feet deep) capable of holding the cumulative wastes produced by the plant would be required for waste disposal. Local groundwater contamination would result if these materials were allowed to escape the confines of the pond.

Land Use

Approximately 500 acres will be utilized during the construction and operation of the coal gasification plant. Mine-site ash disposal would reduce this figure to approximately 350 acres. Use of existing structures and housing where possible will minimize adverse impacts.

Soils

The primary environmental impacts of coal gasification development on soils will be the short-term erosion of compacted silty soil during the construction phase and increases in concentrations of soil contaminants and an associated reduction in soil fertility during the operational phase. As a whole, the low permeability (slow drainage) of the upland Phillips-Absher-Theony soil association creates favorable conditions for water impoundments, sewage lagoons, and landfills.

Vegetation

The major impact to vegetation (flora) will result from the cumulative gaseous, particulate, and trace element emissions from the plant's boiler, emergency flare-off system, gasifiers, and other plant processors. A secondary impact will involve the clearing of land for access roads and process facilities. Most of the vegetation potentially impacted lies within the property boundaries of the base although an area up to approximately 40 miles downwind from the Lurgi plant could be adversely impacted over the long term through the loss of primary productivity (yield) associated with gaseous fumigation. This area is primarily dominated by upland level vegetation communities comprised of western wheatgrass (*Agropyron smithii*) and fringed sagewort (*Artemisia frigida*). "Acid rains" resulting from the plant's gaseous emissions could partially defoliate these communities or change the composition of vegetative species. This would be followed by a reduction in grazing capacity.

Wildlife

The displacement of small mammal species at GAFB would be the predominant impact on wildlife resulting from the development and operation of the Lurgi plant. These species include the western deer mouse (*Peromyscus maniculatus*), the prairie mole (*Microtus ochrogaster*), and the western harvest mouse (*Reithrodontomys megalotis*). Predatory species such as the rough-legged hawk (*Buteo lagapus*), the coyote (*Canis latrans*), and the red fox (*Vulpes vulpes*) might be forced to relocate to find food. The shipment of coal to the GAFB facilities would result in wildlife mortalities through the collision of fauna with trains. Pronghorn antelope (*Antipocapra americana*) migration patterns could be disrupted as a result of a railroad spur line fencing. The exposure of GAFB fauna to gaseous and particulate emissions will result in pathology (disease).

Endangered Wildlife Species

A female Rocky Mountain timber wolf (*Canis lupis irremotus*) was spotted and killed in the Glasgow area during 1978. The ranges of other endangered animal species, e.g., the black-footed ferret (*Mustela nigripes*), and the northern swift fox (*Vulpes velox hebes*), extend into the vicinity of GAFB posing potential legal problems in light of the recent (1978) United States Supreme Court decision regarding the destruction of snail darter critical habitat in Tennessee.

Health and Safety

During both the construction and operation of the coal gasification plant, workers may be exposed to leaks in the plant's high-pressure steam lines, excessive sulfur and other chemical levels (some of which are carcinogenic), low-level radiation, many inorganic wastes (solid and liquid) through spills, obnoxious odors, noise, dust, accidents due to negligence or the improper use of test equipment, and burns. Proper plant design will help to reduce, although not eliminate, these potential problems.

III.6.6 Social Impacts

The implementation of the coal gasification re-use for the Glasgow Air Force Base could have negative impacts on social factors during the construction phase. An increase in population would significantly affect the demand for social services in relation to medical, education, and welfare needs and fire and police protection. However, existing housing, water, and sanitation facilites are adequate to handle the influx of workers. The presence of the migrant construction workers could also alter the existing patterns of social organizations in Valley County. A more detailed discussion of the social impacts of this re-use can be found in Appendix C.

Public Acceptance

The response to survey questions concerning a coal gasification plant located in Valley County was 47 percent in favor, 38 percent against, and 15 percent unsure. Valley County organizations and agencies expressed concern over possible environmental pollution and an increase in taxes; however, no significant socioeconomic impacts were anticipated by the agencies. The Tribal Council at the Fort Peck Reservation and the Valley Resource Council stated they did not approve of the coal gasification re-use for Valley County. Results of the attitudinal survey are detailed in Appendix D.

IV. CONCLUSIONS AND RECOMMENDATIONS

Five potential re-uses for GAFB have been developed and assessed. The assessment of each re-use was made with respect to five different areas. First, the technical feasibility of the proposed plant or process was reviewed to determine if an approach currently in practice or one that might be developed in the future would be suitable for implementation at GAFB. Second, an economic analysis was made to determine the level of capital needed to initiate a project and the potential market for the resulting product. The economic analysis included an estimate of usefulness of existing GAFB facilities for implementing the proposed re-uses. Next, the legal requirements of undertaking the proposed re-use alternatives were examined. The fourth item of evaluation was to conduct a detailed study of each proposed re-use to determine the environmental impacts that would be incurred if the re-use was implemented. The fifth step involved an evaluation process to determine the social impacts of each re-use and to poll the community regarding the acceptability of each potential re-use.

Each suggested re-use has been discussed in detail, and some appear to be more feasible than others. An estimate of the potential for and suitability of each suggested re-use is discussed below. Those re-uses that have the most potential are pointed out. The assessment provided is qualitative in nature. That is, in most instances, a general plan was discussed for each suggested re-use, with the exception of the proposed gasohol plant where very specific detail is provided. The determination of whether one or more of these suggested re-uses are undertaken or not should be made after a thorough examination of the technical, economic, legal, environmental, and social aspects as they apply to a particular process or operation. The discussions provided in Section III of this document provide a sound framework to determine the feasibility of a proposed project and should be used to the extent that they apply. It also should be kept in mind that the methodology used in developing these assessments can be used, by the appropriate people, to evaluate the suitability of other proposed re-uses not considered in this report.

IV.1 Gasohol/Ethanol Plant

The gasohol/ethanol plant appears to be a suitable re-use for GAFB facilities. The concept is technically feasible, and our analysis indicates that such an endeavor could be profitable. The product and by-product (liquid fuels and protein feed) are used by the community, and the raw feedstock (barley) is a commodity produced by the community. Also, the attitudinal survey results and other community feedback indicate that the concept has a high degree of support. No significant adverse environmental or social impacts are anticipated from siting the proposed plant at the base.

IV.2 Modular Home Fabrication Center

Our analysis indicates that a market exists for a quality-constructed, low-cost home in northeastern Montana and Canada. This market, in conjunction with the suitability of the base facilities being used as a fabrication center, provides the motivation to suggest that this would be a viable re-use for GAFB facilities. Attractive aspects of this project are that it requires limited initial capital, it can be implemented quickly, and it would employ a minimum of 30 people at the level of production suggested in this report. No significant adverse environmental or social impacts were identified with this re-use.

The key to the success of this proposed re-use is in acquiring a significant portion of an existing housing market. A suggested method for doing this is to provide quality homes at a low price and incorporate energy-conserving and renewable energy options in the home design.

IV.3 Rail Car Repair Facility

There are apparently no significant technical problems, legal obstructions, or adverse environmental or social impacts associated with the siting of a rail car repair facility at GAFB. In fact, significant benefits from the placement of such a facility would result, i.e., stable work force and permanent income to the VIP complex. The economic viability of the proposed re-use, though, is not as certain.

Two types of facilities were considered in this analysis. One was a small repair facility outfitted only to perform routine maintenance tasks, while the other was a major facility capable of processing large numbers of coal cars that might be required to service a future demand for export of lignite coals. The smaller facility was configured to service the current non-BN rail traffic in the area. However, a first-order analysis of the incident repair work that might be suitable at the proposed facility indicates that the volume would be too low to support the proposed re-use.

A market for rail car repair work on a contract basis might be obtained, though, from the foreign line and private rail car owners that have rail car traffic in the area. This potential was identified in the report and would need further definition by an interested investor. Since over 300,000 private and foreign line rail cars are routed on the east-west BN line south of GAFB, annually, a positive potential exists for establishing this type of enterprise as a re-use of GAFB facilities.

The large-scale operation described has no immediate promise and would only be feasible if local lignite coals were exported from the state. The potential for such an activity should be kept in mind by interested developers in the event this coal export market opens up.

IV.4 Wind Electric Power Production and Wind Turbine Generator Manufacturing Facility

Based on the research conducted thus far and the present state-of-the-art for wind electric generation, a manufacturing facility located at GAFB does not seem reasonable at this time. However, the economics and expected technological advances are expected to increase by 1985 so that wind turbine generator manufacturing will indeed be a viable business opportunity. The potential for this industry, while favorable for GAFB, certainly is not limited to that site alone. In fact, this alternative could represent a significant world-wide industry with plants located in countries all over the world. Therefore, this alternative is one which should be pursued and implemented when it becomes economically feasible.

IV.5 Coal Gasification Plant

Coal gasification does not appear to be a suitable re-use for the GAFB facilities. This re-use would not be compatible with the existing facilities, nor would coal gasification be compatible with an aviation re-use of the facility. The Fort Peck Reservation Indians are expected to obtain a Class I air quality designation, and the anticipated level of emissions from the coal gasification plant could preclude or substantially delay the siting of a coal gasification plant at GAFB.

If such a facility were sited at GAFB, an economic penalty due to hauling coal from a remote mine site could increase operation costs significantly.

A re-use of the housing and community support facilities by transporting workers to a remote plant construction site via air was examined in detail. The plan analyzed in this report indicates that this approach, as opposed to building a temporary construction camp at the site, has no economic advantage. However, this approach might have some merit, by mitigating the adverse sociological impacts so often associated with "boom and bust" communities. As energy development occurs in eastern Montana, this re-use option should be considered on a case-by-case basis.

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APPENDIX A

PHYSICAL OVERVIEW

PHYSICAL OVERVIEW

Introduction

Presented in this Appendix is an overview of Glasgow Air Force Base (GAFB), the city of Glasgow, and Valley County. This information is provided to give the reader an understanding of the study area, GAFB, and the associated community. The discussions presented are generally short, concise statements or explanations. For a detailed discussion of those aspects on which the reader desires more information, he is referred to the references that are made throughout this Appendix.

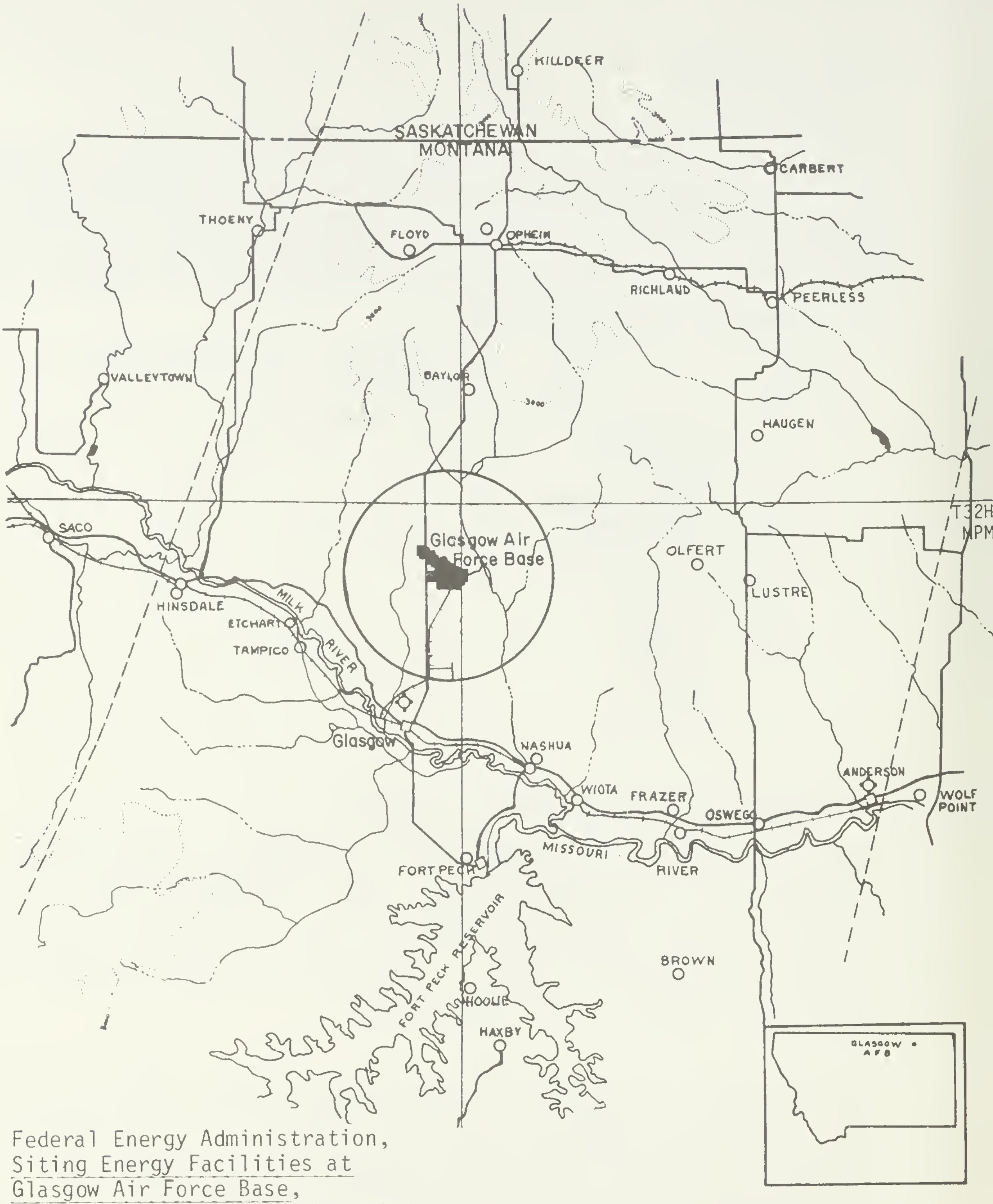
The subjects in this Appendix are presented in the following order.

A-1	Location and Description of the Area
A-2	Topography
A-3	Geology
A-4	Soil/Land Capability
A-5	Climatology
A-6	Water Quality
A-7	Wildlife
A-8	Vegetation
A-9	Land Use
A-10	Economics
A-11	Social
A-12	Cultural
A-13	Political

A-1. Location and Description of the Area

The area described in this environmental assessment lies within Valley County's portion of the upper Missouri River subbasin on the northern Great Plains of northeastern Montana. GAFB is located 18 miles (29 kilometers) north of the city of Glasgow, Montana; 42 miles (67 kilometers) south of the United States-Canada border; and adjacent to the western boundary of the Fort Peck Indian Reservation. Figure A-1 presents a regional map as a graphic description of the study area and territory. The study area was discussed in Section I.4 of the main report.

The base has an elevation of 2,755 feet (840 meters). The property encompasses 5,815 acres of rangeland acquired by the United States Air Force in 1955. The nearest community is Glasgow, Montana with a population of 6,500 according to the latest census data. The nearest city exceeding 50,000 in population is Great Falls, Montana (population 60,868) about 270 miles west. Billings, Montana is about 279 miles southwest (population 68,987). The city of Regina, Saskatchewan in Canada is about 250 miles north of Glasgow Air Force Base.



Source: Federal Energy Administration, Siting Energy Facilities at Glasgow Air Force Base, Executive Summary, November 1975.

Figure A-1.--Regional Map

The base is divided into two major areas--the housing area and the cantonment area. The cantonment area includes aircraft hangers, various warehouses, offices, manufacturing buildings, and other buildings that form the base's infrastructure. The housing area includes dormitories, houses, and parking pads for relocatable houses and mobile homes. The base has ample provisions to adequately house 5,000 people.[1] The housing area also includes a dining hall, hospital, dental clinic, gymnasium/recreation center, restaurant/store, grocery market/food warehouse, live-in training center, fine arts education/community center, and hobby shops.

A-2. Topography

Valley County can be described by its lack of distinctive topographical relief, as is true generally for the Great Plains physiographic province. Figure A-2 is a topographical map of Valley County. The land surface is flat to gently rolling with a mean amplitude (depth variation) of 10 to 15 meters. The more prominent topographical features are the major creeks (Rock Creek, Willow Creek, Porcupine Creek, and Larb Creek) that drain into the Milk River (valley), the Missouri River, and its associated Fort Peck Reservoir. The major drainage systems have dissected the surface to form gullies and valleys. Eastern Montana physiography may be correlated directly with the (limited) complexity of the geological structures underlying the surface. Shales and sandstones of the Upper Cretaceous and Tertiary periods predominate as bedrock. These stratigraphic units lay flat and have weathered to form a subdued terrain with very little relief.

During the Pleistocene Epoch, several stages of continental glaciation deposited a mantle of ground moraine (till) of variable thickness north of the Missouri River in Valley County. Associated glacial outwash deposits extend south for at least 160 kilometers (99.3 miles). Thick fluviolacustrine deposits and diverted river courses also resulted from the glacial activity. The evacuated preglacial upper portion of the Missouri channel is now occupied by the Milk River.

A-3. Geology

Eastern Montana physiography is characterized by geological (structural) simplicity and lithologic monotony when compared to the Rocky Mountain lithology observed in western Montana. The eastern region's stratigraphic record includes a thick sequence of sedimentary and metamorphic rocks that resulted from materials initially deposited in shallow seas during the Precambrian through the Mesozoic Ages. These sediments underwent such events as variable metamorphism, local to regional folding and faulting, and erosion and lithification. These strata are generally overlain by Terriary or Quanternary glacial drift and glaciofluvial materials or unconsolidated recent alluvial gravels. Section 5 of Appendix E presents a more detailed overview of the area's geologic record and history.

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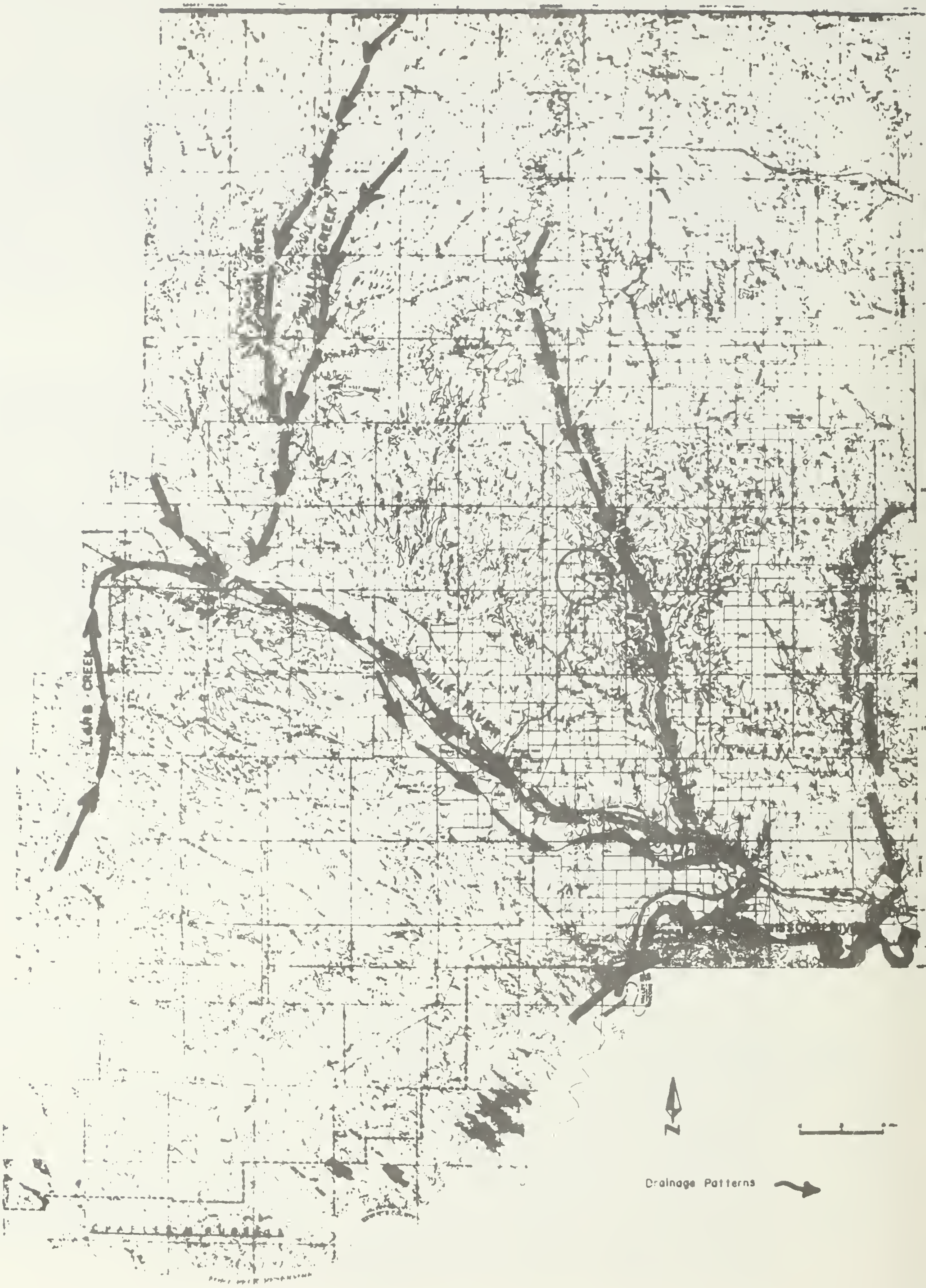
[1] Barracks accommodations for 1,780 men, bachelor officers quarters for 85 personnel, and 1,227 family housing units.



Source: Federal Energy Administration,
Siting Energy Facilities at
Glasgow Air Force Base,
Vol. 1, November 1975.

Figure A-2.--Valley County Topographical Map

The Upper Cretaceous Montana stratigraphic groups include the Fox Hills sandstones and shales, which appear as caprock formations in the less intensively glaciated areas of the county. This formation overlays the Bearpaw shale strate which is the principal bedrock unit of the GAFB; it is a thick (more than 335 meters) monotonous sequence of dark bentonitic sandy and silty shale which weathers to a characteristic gumbo soil. The surficial deposits include Miocene-Pleistocene aged Flaxville gravels, Pleistocene (pre-glacial) Wiota gravels, and glacial till (ground moraine) and outwash (channel/terrace) deposits. Thus, the surface at GAFB is underlain by a heterogeneous assortment of glaciofluvial and other kinds of waterlain deposits, colluvium, and silty-to-sandy glacial drift materials.

The county can be considered to be geologically stable overall with the probability of intense, damaging earthquake activity to be small (relative to southwestern Montana). However, surface evidence of faulting and displacement of young gravel deposits in the vicinity of GAFB suggest that extensive geological/geophysical field investigations should occur prior to the siting of a major energy facility in the area (FEA 1975).

The landscape north and east of the present Missouri River course in Valley County was derived from deposited glacial debris. The north-flowing (preglacial) drainage pattern and the deep canyons of the Little Missouri and Yellowstone Rivers were displaced by the leading, southwestern edge of the continental ice sheets (Illinoian, Iowan, and Wisconsin Ages). Numerous glacial lakes resulted from the dammed water courses until they were drained by the present channels; these lakes left barely visible beach morphologies high along the walls of the present canyons in the area.

A-4. Soil/Land Capability

The county has a continental-type climate, characterized by a wide annual temperature range and 10 to 14 inches total precipitation (75 percent of which occurs from April to September). The geological parent material(s) and regional climate have combined to form the clays, loams, and sandy upland soils characteristic of elevated (2,500 to 3,500 feet above sea level) grasslands or heavy clay to moderately permeable loam soils observed in coulee bottoms, along streams, and other places. There are few dramatic land features, e.g., shale or sandstone outcrops within the study area.

The Phillips-Absher-Thoeny soil association dominates the core of the study region, but other associations within the nearly level to hilly, deep, well-drained soils of the glaciated plains can be readily observed. Although local topographical variability can modify soil forming conditions greatly, the well-drained soils of the major creeks and river floodplain are dominated by the Harlem-Havre-Bowdoin Association. Section 5 of Appendix E contains a more detailed discussion of the soil classification scheme applied to and soil mapping units identified in the Glasgow study area.

The results of applying the USDA's land capability analysis system revealed the existence of relatively equal area proportions of Class III, IV, VI, and VII soil types in the study area.

The following is a description of these land capability categories:

> Class III soils have severe limitations that reduce the choice of agricultural plants and/or require special conservation practices.
>
> Class IV soils have very severe limitations that reduce the choice of agricultural crops and/or require very careful land management.
>
> Class VI soils have severe limitations that make them generally unsuited to cultivation and limit their use largely to pasture, range, woodland, or wildlife.
>
> Class VII soils have very severe limitations that make them unsuited to cultivation and restricts their use largely to pasture, range, woodland, or wildlife.

As a whole, the very low permeability (i.e., slow drainage) of the upland soils creates favorable conditions for water impoundments, sewage lagoons, and sanitary landfills. The major exception to this observation is the porous mixtures of soil types in the drainage areas. Thus, slight to moderate design limitations exist for most of the area while activities having pollution potential (e.g., an improperly sited drain field) are not recommended for siting near stream channels.

Soils in the area support livestock range and are utilized to grow wheat, barley, and other grains via rotational strip farming. The remainder is used primarily for summer livestock grazing. It should be noted that in the gully areas, there may be only small amounts of topsoil as a result of water and/or wind induced erosion.

A-5. Climatology

The following characterizations are based on data collected at a 100-meter (325 feet) MERDI meteorological tower at GAFB. A complete analysis of the data is included in Section 5 of Appendix E. The wind data collection was started on October 25, 1977 and was conducted for one full year. The following discussions are based on that data.

Wind Characteristics

Northwesterly and southeasterly winds predominate at GAFB; southerly and northeasterly winds are rare. Light southwesterly winds are common during nighttime hours and may be associated with a drainage effect. The strongest winds are from the northwest and southeast, while the lightest winds are from the northeast and southwest. Wind speeds at the 10-meter (32.5 feet) level averaged 5.1 meters per second (11.4 miles per hour--mph) during this study; monthly speed averages ranges from 4.1 meters per second (0.2 mph) in March to 6.9 meters per second (15.5 mph) in April. Average wind speeds of 6.2 to 7.8 meters per second (13.9 and 17.5 mph) were observed at the 31.6-meter (102.7 feet) and 100-meter levels, respectively. Above normal wind speeds were observed in all months except March and June.

A comparison of GAFB and Glasgow National Weather Service (NWS) wind data revealed great similarity in both wind speed and wind direction. GAFB data, measured by MERDI on the 100-meter tower, is available for only one year, while Glasgow NWS data is available for many years. This comparison seemed to justify the use of Glasgow NWS long-term data to describe long-term wind characteristics at GAFB.

Temperature Characteristics

Glasgow experiences a wide range in temperature, as well as high day-to-day temperature variability. Monthly temperature averages ranged from -18.7° C (-1.6° F) in January to 20.7° C (69.3° F) in July; in March, temperatures ranged from -26.5°C to 17.8°C (i.e., 15.7 to 64.0° F). Temperatures were well below normal in December 1977, January 1978, and February 1978, with near normal values observed in the other months. Overall, temperatures at GAFB and Glasgow NWS were very similar; the average temperature at Glasgow NWS was 2.6°C (36.7°F) while the average temperature at GAFB was 2.5°C (36.5°F).

Precipitation Characteristics

GAFB is in a semi-arid location; historically, during those months when precipitation fell mainly as rain, GAFB received 244.85 millimeters (approximately 9.99 inches), while 255.77 millimeters (approximately 10.43 inches) fell at Glasgow NWS. This indicates that similar precipitation, as well as the most intense precipitation, occurred in the spring. In June, 99.06 millimeters (4.00 inches) fell, the wettest month, while a one-day total of 34.54 millimeters (1.40 inches) was observed in May. GAFB precipitation data was inaccurate from November 1977 through March 1978 because the instrumentation did not accurately measure the water content of the frozen precipitation. Humidity varied considerably during the year. During winter months, relative humidity averaged nearly 70 percent; and mornings were slightly more humid than afternoons. During August, the least humid month, morning humidities were nearly 70 percent, while afternoon humidities averaged 30 to 40 percent.

Barometric Pressure Characteristics

Barometric pressure at GAFB showed some seasonal variation. The lowest monthly pressure average, 910.6 millibars, occurred in April; this was probably due to the frequent passages of low-pressure systems during that time of year. The highest pressure average, 918.0 millibars, occurred in January; this was probably associated with the prolonged presence of polar anticyclones over the area.

Solar Radiation Characteristics

Both direct beam, normal incidence solar radiation, and diffuse solar radiation show a strong seasonal dependence. Direct beam radiation is greatest during the summer months and least during winter. The highest values generally occur around noon, except in May, June, and August when the highest values usually occur one or two hours before noon (DST). Diffuse radiation values are lowest in fall and early winter and highest in spring. Diffuse radiation values are usually highest around midday.

Air Quality

MERDI's air quality program consisted of collecting 24-hour high-volume air samples every third day and setting out a dustfall jar and static samples for a month at a time. The high-volume samples and dustfall jars were analyzed for total particulates and 28 trace elements. In no case did any measured value of any parameter exceed the appropriate standard (see Section 5 of Appendix E). In one instance, January 1978, the amount of dust collected exceeded the standard for residential areas. The standard is based upon a three-month average; however, no three-month averages of the measured values exceeded the standard.

A-6. Water Quality

Physiochemical Parameters

The site-by-site presentation of chemical and physical analyses of the field samples is included in Section 5 of Appendix E. This presentation was prepared by ECON, Incorporated of Helena under subcontract to MERDI during 1978. Most waters sampled were similar in composition, reflecting the sedimentary nature of the area's lithology. The dominant cation (positively charged ions) were sodium, calcium, and magnesium, while the negatively charge anions were most often bicarbonate and sulfate. The waters are generally high in dissolved salts, with specific conductance values often exceeding 1,000 microsiemens. Concentrations of the analyzed heavy metals were low in all tested samples, as is to be expected from the high alkaline characteristics of the local waters. Although no trace element concentration range appears to be threatening to public health or welfare (including natural ecosystems), a comparison of ECON, Incorporated data with that gathered by the USGS (from October 1969 to September 1972) seems to imply that slight rises have occurred in the levels of zinc, iron, chromium, and flouride ions in the Milk River near Nashua, Montana (FEA 1975).

The ortho-phosphorous and inorganic (nitrate/nitrite) nitrogen levels were high enough to constitute eutrophic conditions at the artificial pond sites (number 1 and 2). The lowest dissolved oxygen concentration measured at Site 1 (the "Trout Pond") was 6.8 milligrams per liter in March 1978, under approximately 90 centimeters (35.4 inches) of ice cover and 10 centimeters (3.9 inches) of snow. The dissolved oxygen levels at this site are very adequate for the survival of trout (EPA, Quality Criteria for Water, July 1976). See Figure A-5 for site locations.

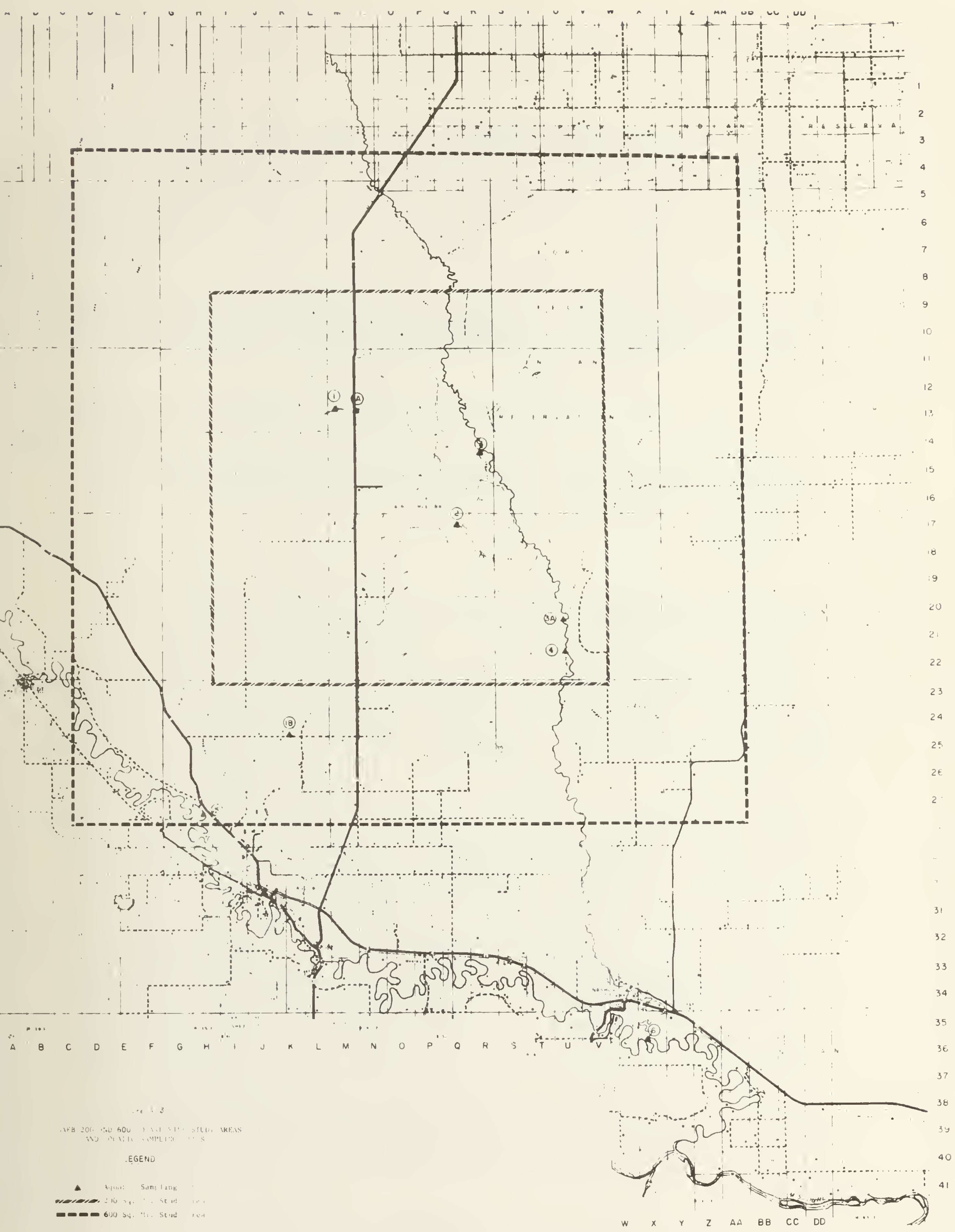


Figure A-3

GAFB 200 AND 600 SQUARE MILE STUDY AREAS
AND AQUATIC SAMPLING SITES

Dissolved oxygen concentrations dropped at Sites 3 and 4 (Porcupine Creek) during periods of ice cover; observed values were lower at Site 4 as a result of the presence of cattle feeding operation near this site. The effects of this activity were also reflected in elevated ammoniacal-nitrogen and ortho-phosphate concentrations. Turbidity and non-filterable residues (suspended solids) remained low during the spring run-off, indicating that little surface erosion is occurring in the upper Porcupine Creek drainage.

Sites 5 and 6 (Milk River) have very similar average major ion ratios. There was a downstream increase in chloride concentration and specific conductance, a downstream decrease in sulfate and bicarbonate concentrations, and a downstream decrease in turbidity and non-filterable residue during peak spring run-off.

Site 1A, the gravel pit on the northwest corner of the GAFB, contained water significantly different from all the other waters sampled. The average alkalinity was less than 21.0 milliequivalent per liter and total hardness of about 3 milliequivalents per liter, with calcium as the dominant cation. This would indicate that surface run-off probably is the major input.

Biological

The results of the analysis of the invertebrate samples are included in Section 5 of Appendix E. Chironomid fauna were dominated by *Chironomus* species at Sites 1 and 2 (as expected in eutrophic ponds) with less chironomid diversity found at Site 2. The differences between chironmid fauna at these sites are probably the result of differences in water chemistry, substrate characteristics, plant productivity, temperature regime(s), and water level fluctuations. Damselflies (Odonata-Zygoptera), water boatmen (Hemiptera-Cerixdae), and mayflies (Ephemeroptera) are major components of the invertebrate fauna. The invertebrate fauna collected at Sites 3 and 4 are typical of slow-moving, warm water streams. Densities of organisms were low, indicating low primary productivity and lack of stability in the community (due to severe substrate scouring by run-off and snowmelt). Large numbers of *Callabach's* species (Ephemeroptera) were collected at both sites in September and October using hand nets. The may fly genus *Leptophelebeia* and the "scud" (Decapoda) genera *Hyallela* and *Gammarus* were also collected in abundance. Surber and Hester-Dandy samples were collected at Site 5 about 100 meters downstream from an irrigation intake pipe; the riffle area sampled had a heavily silted (20 to 25 centimeter) rubble substrate. The invertebrate fauna was dominated by buffalo ganst (Diptera, *Simulium*) and the caddisfly genus *Chematosyche*. Taxa unique to this site were the beetle (coleoptera) genera *Dubiraphia* and *Stenelmis*. The absence of *Simulium* at Site 6 indicates the lack of a firm substrate along this particular reach of the Milk River. Community diversity was very low with burrowing or tub-building chironomidai being the predominant macroinvertebrate forms and *Polyuntropus* (Trichoptera-Caddisfly) and *Argia* (Ordonata-Zygoptera-Damselflies) being the only other genera present.

Standing crops of phytoplankton at Sites 1 and 2 were relatively high. Results of chlorophyll analysis in phytoplankton are shown on the next page.

Chlorophyll A, milligram per cubic meter

Site	Sept. 1977	Oct. 1977	April 1978	June 1978
1.........	62.4	6.71	16.91	29.45
2.........	35.3	13.34	22.38	7.24

An appreciable portion of both Sites 1 and 2 were colonized by vascular aquatic plants. The ponds' border (emergent zone) flora included the great bulrush (Scirpus validus Vahl.) and spike-sedge (Eleocharis R. Br.) species. The submersed zone included two pondweed species (Potamogeton pectiratus L.; P. richardsonii, A. Benn.), hornwort (Certophyllum demersum L.), and American milfoil (Myriophyllum exalbescens Fenn.). Aquatic vascular plants contribute significantly to plant productivity in both ponds and enhance their desirabi ity (particularly in the presence of P. pectinatus).

The results of periphyton sampling and analysis for Sites 3 and 4 are presented in Section 5 of Appendix E. Rates of chlorophyll and biomass accural are low in most cases in spite of an apparent abundance of nutrients at all the sites investigated. A lack of well-developed aufwuchs (benthic) community at Sites 3 and 4 was notable although unattached filamentous algae grew profusely.

The fish community at Site 1 included the brassy plains minnow (Hybognathus hankisnoni), October 1977; stickleback (Culaea incorstans), September 1977; and rainbow trout (Salmo gairdueri), June 1978. No fish were collected or observed at the second site. Fish species collected in Porcupine Creek or adjacent backwaters included the longnose dace (Rhinicthys cataractae), northern pike (Esox lucius), and the brassy plains minnow. The Milk River and its larger tributaries support a moderate sport fishery for walleye (Stizostedion vitreum), sauger (S. canadense), goldeneye (Hiodon alosoides), and northern pike. Other game fish and nongamefish species are listed in Section 5 of Appendix E.

The biological data reflects the nature of the habitats sampled. The instability of habitats of Sites 2, 3, and 4 is reflected in the low diversity of taxa encountered. The density of organisms in Porcupine Creek is probably controlled by spring flooding. Milk River fauna decreased in diversity downstream, probably in response to siltation which reduced habitat diversity. Productivity in both Porcupine Creek and Milk River was low, and the aufwuchs community was poorly developed. These drainages lack stable flow, are scoured, and lack suitable substrates (rocks, boulders). In general, the analysis of the sampled physiochemical and biological parameters show fair to good water quality characteristics.

A-7. Wildlife

Major Wildlife Species

There are substantial populations of major wildlife species found within the 600-square mile area studied by ECON, Incorporated under subcontract to MERDI during 1978. The following table is a summary of all observations made of major wildlife species during the 15-month study period (1977 to 1978).

Major Wildlife Species

Species	Total Observation[a]
Pronghorn Antelope (*Antipocapra americana*)	5,801
Mule Deer (*Odocoileus hemionus*)	1,197
White-Tailed Deer (*Odocoileus virginianus*)	389
Sharp-Tailed Grouse (*Pedioecetes phasianellus*)	461
Sage Grouse (*Centrocercus urophasianus*)	50
Hungarian Partidge (*Perdix perdix*)	130
Ring-Necked Pheasant (*Phasianus colchicus*)	34
Waterfowl (seasonal and resident species)	1,234
Coyote (*Canis latrans*)	37
Red Fox (*Vulpes vulpes*)	12
Raptors (seasonal and resident species)	297

[a] Summation of observation travel route and incidental sightings.

The migration of antelope herds from areas north and west of the study area during the unusually severe winter of 1977 to 1978 produced elevated population densities as the antelope attempted to winter or pass through the GAFB environs. Such migration to and through the area only occur during severe winters; the last incidence occurred about 10 years ago (Trueblood 1977). It is not known how many antelope winter in the study area during average winters.

The ECON, Incorporated habitat diversity and utilization (HD&U) analysis system revealed that major wildlife species most often frequent the grassland, coulee bottom, agricultural grain fields, and abandoned field habitat types. Avian diversity was greatest in the creek bottom habitat type, although the upland gamebird species could also be found in the grassland, coulee bottom, and silver sagebrush (Artemesia cana) grassland habitat types. The summary of frequency of occurrence and percent of area occupied by a given species for each habitat type can be found in Section 5 of Appendix E.

Minor Wildlife Species

Systematic sampling of small mammal, songbird, reptile, and amphibian populations was conducted on a seasonal basis. Species identification, population density estimates, and habitat usage data were collected for selected sampling and observation sites throughout the GAFB study area.

Three small mammal species represented 100 percent of the trapping results. For all habitat types combined, the western deer mouse (Peromyscus maniculatus) contributed 89 percent to the total catch. The prairie mole (Microtus ochrogaster) and the western harvest mouse (Reithrodontomys megalotis) contributed six percent and five percent, respectively. Section 5 of Appendix E presents the results of the complete trapping operation by season.

A total of 103 separate bird species were observed during both formal route observations and while conducting other field work. A complete listing of raptors, songbirds, birds of prey, waterfowl, etc. observed by ECON, Incorporated field personnel, including habitat use and season(s) of occurrence, appears in Section 5 of Appendix E.

Some of the more uncommon species include the rough-legged hawk (Buteo lagopus), golden eagle (Aquila chrysaetos), Gyraflacon (Falco rusticolus), prairie falcon (Falco mexicanus), pigeon hawk (Falco columbarius), and snowy owl (Nyctea scandiaca). Both the gyrafalcon and snowy owl were present only during the winter and were apparently residing in the area as a result of the adverse weather conditions occurring in the north. Both the Wilson's phalarope (Steganopus tricolor) and northern phalarope (Lobipes lobatus) were observed near Waterfowl Census reservoir #2 during the spring of 1978. In addition, the rather uncommon red-headed woodpecker (Melanerpes erythrocephalus), loggerhead shrike (Lanius ludovicianus), and McGowans' longspur (Rhynchophanes mccownii) were also observed.

The only species of reptiles or amphibians observed in the GAFB study area were the plains and common garter snake (Thamnophis radix and T. sirtalis), the western painted turtle (Chrysemys picta), and the leopard frog (Rana pipiens). Each of these were fairly common throughout the study area along or in stock ponds or other water impoundments. The prairie rattler (Crotalus viridis) has also been reported to occur in the western portion of the study area, but none were observed.

Waterfowl Survey

Maximum counts of waterfowl occurred during May which represents the peak of the northward migration of this species. The lesser scaup (Aythya affinis), blue-winged teal (Anas discors), mallard (Anas platyrhynchos), and pintail (Anas acuta) were the most common species occurring in the five study reservoirs. The subfamily Merginae, represented by the common merganser (Mergus merganser) and red-breasted merganser (Mergus serrator), were present only during April. Both these species have a more northern breeding range (Bellrose 1976) and were present only in transition.

The GAFB study area is located within the Great Plains which is considered one of the most important waterfowl production areas in North America (Bellrose 1976). Canada goose pairs and nests were present on two reservoirs. No Canada goose broods were observed on any of the study reservoirs while at least one brood was hatched on a reservoir not included in those censused.

Waterfowl broods were observed on three of the five study reservoirs. Successful broods on study reservoir #1 include American wigeon (Anas americana), shoveler (Anas clypeata) and the lesser scaup. Broods of canvasback (Avthva valisineria) were observed on study reservoir #2, and mallard and pintail broods were sighted on study reservoir #3. The complete results of the waterfowl survey appear in Section 5 of Appendix E.

Game Bird Breeding Surveys

Breeding surveys were conducted on the following species: pheasants, mourning doves, and prairie grouse. Brood searches were conducted with the aid of a trained bird dog during the spring of 1978. All broods observed during incidental and route observations were recorded.

The pheasant crowing count route on the Porcupine Creek drainage in 1977 revealed an average call count of 4.6 per station. The same route revealed a 1978 call count rate of 0.4 per station. The average number of calls per listening station on the Cherry Creek drainage during 1978 was 3.2.

Mourning dove cooing count runs revealed an average of 34.0 on the Porcupine Creek route and 15.2 calls per station on the Cherry Creek route. Because these routes were run only in the spring of 1978, no comparison data are available to predict population trends. However, with the large winter wheat fields present and the deciduous overstory creek bottom vegetation and silver sage-grasslands available for nesting cover, the area should produce a sizeable number of mourning doves.

During the spring of 1977, only three prairie grouse leks (strutting ground) were located. An additional five leks were located during the spring of 1978. In addition to the aforementioned wildlife studies, special surveys in the form of deer and antelope reproduction indices, raptor nest searches, game species' food habits and hunting pressure survey(s), e.g., for big game and furbearer species, were completed. The results can be reviewed in Section 5 of Appendix E.

A-8. Vegetation

Through the use of aerial surveys and stereometric false-colored infrared film (1" = 2400' scale), ECON, Incorporated personnel identified and mapped (1" = 2000' scale) five basic vegetative community types throughout an intensive 200 square-mile study area. The five habitat types include 1) upland level sites; 2) upland hilly sites; 3) lowland sites; 4) juniper-grassland sites; and 5) overstory (tree/schrub) communities. Details of each range site type (including commentary on soils and floral inventories), biomass production, and diversity indices are given in Section 5 of Appendix E. An overview of each habitat type is given below. Vegetation sampling sites referred to in this section are shown in Figure A-6.

Upland Level Sites

The vegetation community for the upland level sites is dominated by western wheatgrass (*Agropyron smithii*) and junegrass (*Koeleria cristata*), other dominant grasses include needle-and-thread (*Stipa comata*) and blue grama (*Bouteloua gracilis*).

Fringed sagewort (*Artemisia frigida*) is the dominant forb with American vetch (*Vicia americana*) and rough flase pennyroyal (*Hedeoma hispida*) occurring at relatively high frequencies.

Broom snakeweed (*Gutierrezia sarothrae*) was the only shrub or half-shrub taxon present.

Range conditions for three production sites ranged from high-fair to low-good. Community diversity indices were second only to the upland hilly sites.

Upland Hilly Sites

The dominant taxon for the upland hilly sites is needle-and-thread. Other important grass species include western wheatgrass, junegrass, and blue grama.

Scarlet globemallow (*Sphaeralcea coccinea*), Hood's phlox (*Phlox hoodii*), and fringed sagewort share forb dominance.

Plains pricklypear (*Opuntia polyacantha*) was the only half-shrub species occurring with the sample plots. Range condition for two production sampling sites was good to high-good. Results of the diversity index calculations indicate that the upland hilly sites are the most stable and mature of the grassland sites.

Lowland Sites

Lowland sites sampled in 1978 represent two distinct communities. An inundated sedge meadow (L-1) was dominated by sedge (*Carex*) and rush (*Juncus*) species. Reed-grass (*Calamagrostis*) species, foxtail barley (*Hordewm jubatum*), and alkali dropseed (*Sporobolus airoides*) are also present. Spearmint (*Mentha spicata*) is the dominant forb in this community.

The remaining two lowland sites samples (L-2, L-3) were located in coulee bottoms which periodically received runoff water. Dominant grasses on these sites include western wheatgrass and desert saltgrass (*Distichlis stricta*). Other regularly occurring grass taxa include canby bluegrass (*Poa canbyi*), Sandberg bluegrass (*Poa secunda*; *P. sandbergii*), and green needlegrass (*Stipa viridula*).

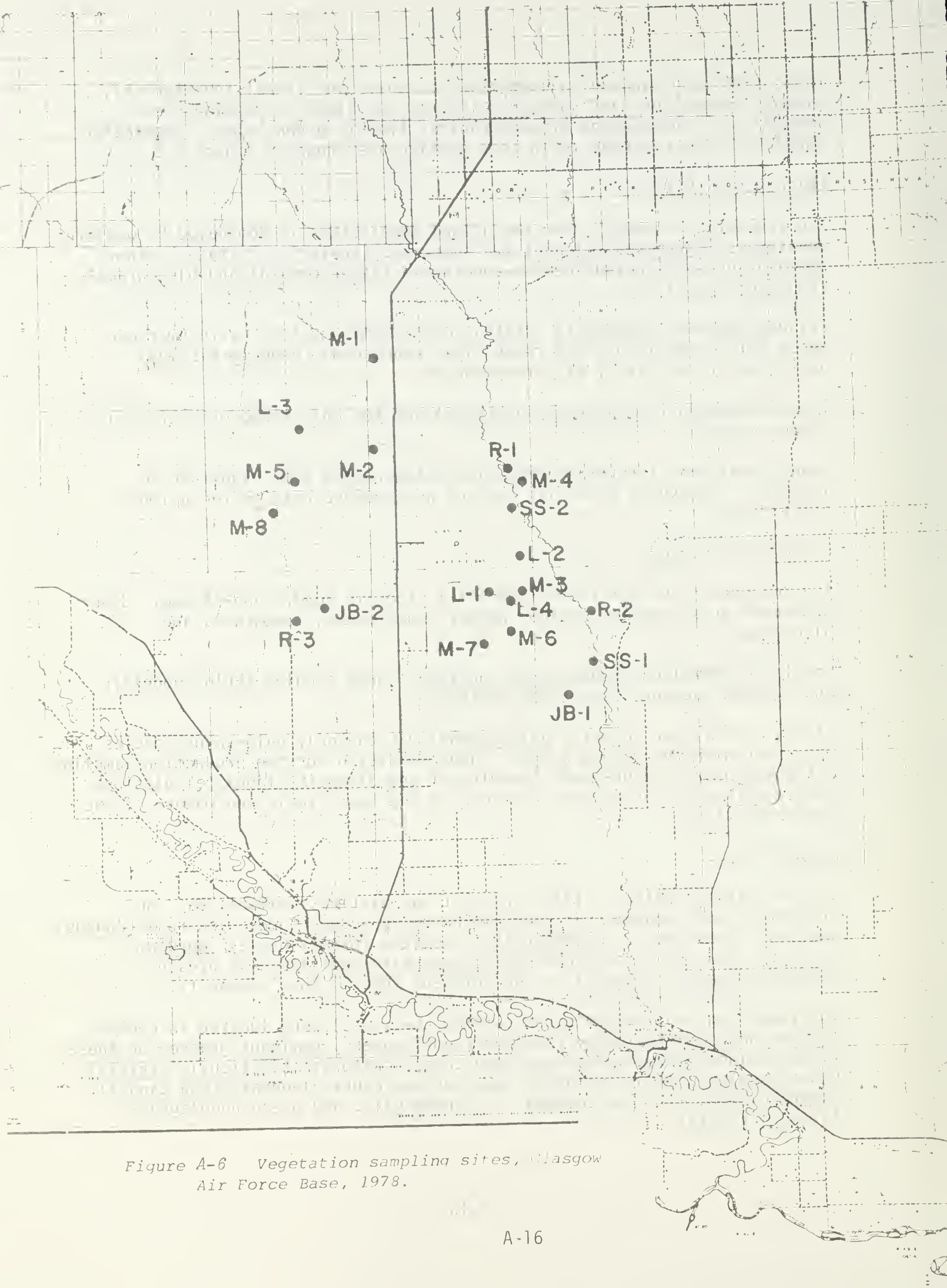


Figure A-6 Vegetation sampling sites, Glasgow Air Force Base, 1978.

Regularly occurring forbs include yarrow (Achillea millefolium), littleleaf penstemon (Penstemon procerus), and American vetch.

Shrubs and half-shrubs represented in this community include silver sage (Artemisia cana), rubber rabbit brush (Chryosthamus nauseosus), wild licorice (Glycyrrhiza lepidota), broom snakeweed, and plains pricklypear. Range conditions for two production sampling sites were low-good to good. Diversity indices indicate a less stable community with a larger proportion of sporadic species than the other vegetation associations (e.g., upland grassland habitat types).

Juniper-Grassland Sites

The juniper-grassland community occurs in steep landscapes and is dominated by creeping juniper (Juniperus horizontalis). Dominant grasses include little cluestem (Andropogon scoparius) and prairie sand reed grass (Calamovilfa longifolia).

Commonly occurring forbs in the juniper-grassland include pale bastard toadflax (Comandra umbellata), prairie thermopsis (Thermopsis rhombifolia), and American vetch.

Besides creeping juniper, other shrub or semishrub include broom snakeweed, plains pricklypear, and prairie rose (Rosa arkansana). Range conditions for one productivity sampling site was high-good.

Overstory Sites

The creek bottom habitat type is distinct in that it includes the only areas with naturally occurring deciduous tree taxa. The northern Porcupine Creek (R-1) study site's overstory is dominated by peachleaf willow (Salix amygdaloides) followed by plain's cottonwood (Papulus deltoides), green ash (Fraxinus americana), and chokecherry (Prunus virginiana). Domination by peachleaf willow, along with the relatively high stand density, indicates that this site is less mature than the other sampling stands.

The southern Porcupine Creek sampling site (R-2) is dominated by plains cottonwood followed by green ash and peachleaf willow, respectively. Green ash has the highest importance value in this stand which, along with the high frequency of green ash seedlings, indicates that this site is in a more advanced seral stage.

The site sampled on Cherry Creek (R-3) is dominated by green ash. Only peachleaf willow was encountered along with the green ash and was present mainly on the periphery of the wooded area. Seedling counts were very low within the stand due in part to the nearly closed canopy situation. Stand density was the highest at this site.

The coulee bottom habitat types (L-3, L-4) show the greatest diversity of shrub species present. Shrub species represented include common snowberry (Symophoricarpos albus), Wood's rose (Rosa woodsii), silver sage, and wild licorice.

A-9. Land Use

The most recent (1975) U. S. Department of Agriculture statistics on Valley County land use and ownership show that 48 percent of the land (or 1,585,280 acres) is under federal jurisdiction. The majority of these lands are administered by the USDI Bureau of Land Management; 1,130,880 acres (35 percent) are privately owned; 336,000 acres (10 percent) are located within the Fort Peck Indian Reservation; and 214,000 acres (7 percent) are under state jurisdiction.

Grazing (predominantly on rangelands) is the major land use. Cereal grains are produced on dry croplands using an alternate crop-fallow system. A large share of the hay base for the livestock industry is produced on irrigated crop and hayland. Wooded acreage is presently used for grazing although 80 percent of these woodlands contain marketable timber.

A-10. Economics

Community Income

The county seat of Valley County, Glasgow, is the center of a large agricultural area which presently contains 40,000 acres of irrigated farmland. The Glasgow Chamber of Commerce estimates that farm and ranch income contributes over $35 million annually to the local economy. The principal crops include wheat, barley, and oats, and livestock is composed mainly of cattle and sheep.

The trade area for Glasgow includes all of northeastern Montana and southern Saskatchewan. A total of 160 retail stores are located in three shopping areas of Glasgow. Retail, wholesale, and service trade business is estimated at $36 million annually by the Glasgow Chamber of Commerce.

Housing

In the last five years, 50 new homes have been built in Glasgow, and the Glasgow Public Housing Authority currently offers 60 low-rent units (Chamber of Commerce 1977). Ten trailer courts contain 323 trailer spaces. A facility is presently under construction that will provide 100 apartments for ambulatory senior citizens.

Welfare

As of January 1, 1977, 1,519 people were receiving social service benefits totaling $291,081 for the year of 1976 (HEW, Social Security Administration 1977). In June 1977, 114 people were receiving medicare benefits with monthly payments totaling $11,547.

Aid to dependent children totaled $210,287 for an average of 103.4 cases per month during 1977 (State Department of Social and Rehabilitation Services 1978). Medicaid paid $565,459 for an average of 261.5 cases during 1977. In 1977, a total of $316,887 worth of food stamps was purchased by an average 46.7 households.

Transportation

Air--Frontier Airlines serves Glasgow with three daily flights (except weekends) to other major national air centers.

Bus--Missouri Trails, Incorporated provides bus services for the Glasgow area to all of Eastern Montana and North Dakota.

Car--Hertz and Payless provide car rentals, and a local taxi service is available.

Rail--Burlington Northern provides freight service and truck/bed repair. Between 14 and 25 trains (75 to 100 cars each) go through Glasgow daily. Amtrack currently provides passenger service, east to west, four times a week.

Highway--Transcontinental Highway 2 is the major east-west traffic system through Valley County, and Highway 24 runs north-south. A total of 173.5 miles of state highway is located in Valley County.

Land Values

Valley County has a 1977 total assessed value of $82,224,253, a taxable value of $20,260,487, and a mill rate of $235,079 per annum. Glasgow has an assessed value of $20,950,572, a taxable value of $4,901,714, a bonded indebtedness of $77,500, a city-owned property book value of $11,450,856, and a 1977 mill rate of $73.38.

Utilities

The Montana Power Company is the major supplier of electricity for the city of Glasgow. Valley Electric Co-op is the primary source of electricity for the outlying farms and communities. Natural gas is supplied by Montana-Dakota Utilities from the Bowdoin Field about 50 miles west of Glasgow. Mountain Bell provides phone service within the city, and Valley Rural Co-op services the rest of the county.

Accommodations

Combined hotel and motel rooms total 214. A new 100-unit motel is currently under construction. Dining facilities include four supper clubs, six cafes, four drive-ins, and one pizza parlor.

Employment

During 1978, 50 to 60 people were unemployed. This represents an all-time low-unemployment rate of five percent. Approximately 250 people were unemployed in 1977 according to Montana Job Service officials.

A-11. Social

Community Affairs

The annual fair and rodeo is held during the second and third weeks of August in Glasgow. Local merchants sponsor a crazy days/harvest festival during the third week of October which includes a community barbecue and dance.

School System

Valley County contains eight school districts with a total enrollment of 2,821 for the school year of 1977 to 1978 (Montana Superintendent of Public Instruction 1978). Glasgow has an enrollment of 1,829 and employs a staff of 180.

Sports, Recreation and Entertainment

Valley County contains several recreation areas including Charles M. Russell Range, Fort Peck Dam and Reservoir, and Pines Recreation Camp. Principal recreational activities in these areas are hunting, fishing, boating, and camping.

The city of Glasgow provides a bowling alley, theater, drive-in theater, pool, golf course, softball and baseball diamonds, basketball, tennis, and racquetball courts.

The Northeast Montana Fair and Rodeo is held annually the second week of August. Exhibits include livestock, crops, garden and floral, fine arts, and homemaker handiwork.

Glasgow has six city parks currently in operation and one that is undeveloped. These include picnic facilities, playgrounds, tennis courts, and a swimming pool.

Clubs

Over 70 clubs and organizations exist within Glasgow. These include Kiwanis, Lions, Business and Professional Women, Odd Fellows, Soroptomists, Saddle Club, and both a Junior and Senior Chamber of Commerce.

Library

The library is owned jointly by the city and county and serves as headquarters for a five-county area. Rural services is available through a bookmobile, and interlibrary loans are possible through regional teletype service.

Museum

The Valley County museum is located in a new building on Highway 2. Exhibits include local historical displays, artifacts of the Sioux and Assiniboine tribes, and a moon walk exhibit.

Fort Peck Museum has displays including dinosaur and plant fossils as well as histroic white and Indian artifacts.

Arts

Four concerts are performed each season by the Glasgow Community Concert Association. The Fine Arts Council sponsors a summer theater program at Old Fort Peck. The high school band has won many national and international music awards.

Archeological

As of June 1977, 344 well-documented archeological cultural resource sites were registered by the Bureau of Land Management. Included in the Valley County Planning Unit are five historical sites and one paleontological site.

In August 1978, MERDI contracted ECON, Incorporated to perform a cultural resource surface reconnaissance of GAFB. The work was performed by Leslie B. Davis, Ph.D., assisted by Steve Aaberg, B.S. Sixteen sites were located, predominantly in the northeast corner of the property, although both the extreme southern margin and the east edge of the base contain prehistoric features. Fifteen of the sites are comprised of rock features, and only one is defined by the exclusive presence of lithic scatter. Six sites include one or more stone circles (tipt rings), and three sites contain one or more rockpiles. A small rock-lined hearth and an amorphous effigy boulder figure also were recorded.

A complete description of the surface reconnaissance data is included in Section 5 of Appendix E. These data do not suggest that any of the sites are eligible for listing in the National Register of Historic Places. Mapping, excavation, and/or photographs of the sites are recommended prior to any development. If the testing and sampling necessary for mitigation reveals additional data, then the status of the sites will have to be re-evaluated.

A-12. Cultural

The city of Glasgow has a population of 6,500 (1975 census) and occupies 809 acres in south central Valley County, Montana. Glasgow is located on the Milk River near the center of an agricultural area whose major products are wheat, barley, oats, sheep, and cattle.

Historic

The first recorded white men in this area were Lewis and Clark (April 1805). The area experienced an influx of fur trappers during the next 30 years, and Fort Peck was established as a trading post about 18 miles south of Glasgow. Buffalo were very common in the area until the 1870's when they were virtually eliminated by professional hunters. Cattle ranches started developing about 1885, and the railroad reached Glasgow in 1887. Homesteading brought hundreds of farmers to the area in 1913. The construction of Fort Peck Dam brought thousands of construction workers to the area during the period from 1933 to 1937. In 1954, work began on GAFB and continued until its abandonment by the Air Force in 1968. The base now contains Valley Industrial Park, a development organization interested in bringing business and industry to the base facilities.

Medical Services

A new 54-bed hospital and two clinics provide medical services for Glasgow and Valley County residents. Air ambulance service is available from Wokal Flying Service. Complete nursing home facilities are provided by the Valley View Home for 95 residents.

Religion

Glasgow has 12 Protestant churches, two Mormon churches, and one Catholic church. A ministerial association has representatives from each church. Several new churches have been constructed during the last five years.

Aesthetics

Valley County is characterized by clean air, grassy plains, and rolling hills. Fort Peck Lake provides exceptional water recreation resources. Local inhabitants consider this area's hunting and fishing to be among the very best in the nation.

Communications Services

The major newspaper is the Glasgow Courier. There are no television stations although television is available via translator stations. Radio KLTZ is the only local broadcaster.

A-13. Political

Participation

The June 1977 primary election had a 52.8 percent voter turnout totaling 3,003 persons. The County Clerk reported this was an unusually low figure; participation is usually close to 80 percent. A total of 3,262 people voted for the 12 school levies last year. Only three of the five levies failed to pass.

Crime and Law Enforcement

Valley County has four full-time law officers with patrol cars and a volunteer force of twelve deputies. The city of Glasgow employs ten full-time policemen. The Air Force base has a ten-man security unit. This security unit is paid for by the tenants of GAFB and by DOD. The funds are administered by VIP. The Montana Highway Patrol employs five men in Glasgow (one as a driver's license examiner). The Valley County Sheriff reports no unusual or problematic crime trends in the county.

Legal System

Valley County has two justices of the peace who are elected for four-year terms. There is also a juvenile officer and a district judge for the county.

Legislative and Government

Valley County is part of five state legislative districts which includes Montana representative districts 3, 4, and 5 and senate districts 2 and 3. At this time, all state representatives are Republicans. One state senator is a Democrat.

All county officials are elected to four-year terms except the commissioners who serve six-year terms. County officials include the clerk and recorder, treasurer, clerk of court, district judge, juvenile officer, sheriff/coroner, county attorney, justice of the peace, county superintendent of schools, nurse, and sanitarian. The city of Glasgow employs a mayor, six alderman, a city engineer, and a recreation director.

News and Services

No political newsletters are currently published in Valley County. Party headquarters are established in Glasgow prior to each election to supply information to citizens.

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APPENDIX B

LEGAL REQUIREMENTS

LEGAL REQUIREMENTS

Considering each of the re-use alternatives presented below, a survey was made of all relevant state and federal laws, standards, and permits.

1. Gasahol/Ethanol Plant

2. Modular Housing Fabrication Center

3. Rail Car Repair Facility

4. Wind Electric Power Production and Wind Turbine Generator Manufacturing Facility

5. Coal Gasification Plant

The table on the following page delineates applicable requirements for each re-use scenario. The horizontal axis indicates the various state, federal, and other laws which might apply to each alternative, and the vertical axis is a list of each alternative and its various components. If there are legal requirements associated with an alternative or a component, an "x" is placed at the horizontal and vertical intersection. If there is no "x," there are no legal requirements associated with that alternative or component.

Detailed discussions of the legal requirements for each suggested re-use are provided in Section 2 of Appendix E.

	MEPA/NEPA	Facility Siting Act (DNRC)	Air Pollution Permit (AQB; EPA)	Water Pollution Permit (WQB; EPA)	Solid Waste Permit (SEP)	Hazardous Waste Permit (SWB; EPA)	Occupational Health & Safety (O-B: WCD: OSHA)	Fire Inspection (FMB)	Water Use Permit (DNRC: C of E	OFF-SITE LAND DISTURBANCE	Streambed Alteration (SWCD: F	Dredge & Fill Permits (C of E)	[illegible] Control (SWCD)	Historic Sites Preservation (	Highway Right-of-Way Use (DH)	[illegible] Line Construction (LGF	[illegible]	[illegible] Life Coordination	[illegible] Preservation (ACHP)	[illegible] River [illegible]	[illegible] (FWS)	COAL MINING	Lease [illegible] L: DOI	Mining & Reclamation (DSL	Coal Mine Safety (MLD)	M[illegible]	[illegible] Administration (DA	[illegible] Registration (EP	Cattle F[illegible] Registration (DAG)	[illegible]	[illegible] Regulation/P[illegible]
[illegible] PLANT	X	X																													
Coal Fired Boiler			X	X																											
[illegible]ification Process			X	X	X		X																								
[illegible]al Preparation			X				X																								
Plant Operation							X	X																							
[illegible] Diversion/ [illegible]eline									X			X		X				X													
[illegible] Disposal					X	X																									
[illegible]			X																												
[illegible] Line Construction																															
[illegible] truction											X	X																			
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Operations					X		X																								
WIND FARM																															
Construction & Operation		X																													

LEGAL REQUIREMENTS

APPENDIX C

ENVIRONMENTAL AND SOCIAL IMPACTS

INTRODUCTION

This appendix details the information compiled from the environmental and social impact assessments of each alternative re-use suggested. The environmental impact assessments included compiling baseline data and collecting current data for the following areas:

1. Climate and Air Quality
2. Water Quantity and Quality
3. Solid Waste Generation
4. Wildlife and Endangered Species
5. Health and Safety

Assessing the impact of each re-use alternative on the social structure of Valley County involved compiling baseline data on the area's statistics and projecting the affect each re-use would have in the areas of employment, crime, welfare/unemployment, medical facilities, education, street systems, business, and religion. As part of the social study, an attitudinal survey was conducted to determine the feelings of Valley County residents, businesses, and Indian tribes to growth in and development of the area. The results of this survey are presented in Appendix D.

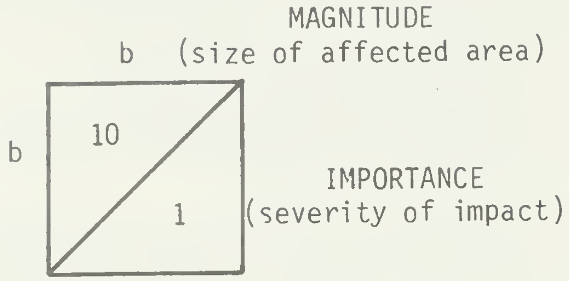
For both the environmental and social assessments, visual abstracts of the potential impacts of each alternative were developed using the Leopold Matrix Assessment Procedure. The use of this matrix procedure is explained below.

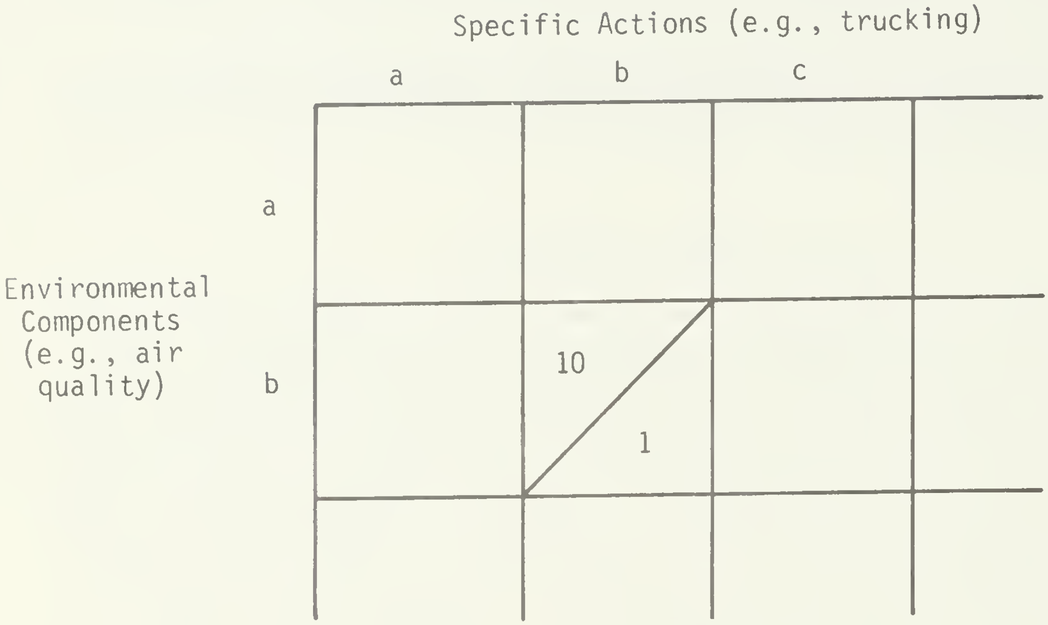
Leopold Matrix Methodology

Charts C-1 through C-5 are Leopold matrix representations of the environmental and social impacts associated with each alternative. The horizontal axis is a list of proposed actions associated with each alternative. The vertical axis is a list of the environmental and social conditions or parameters which may be impacted by each action. At the intersection of each horizontal and vertical axis are two numbers. The figure on the next page is an enlarged view of a Leopold Matrix showing the two numbers which may be contained at the intersection. The upper left hand number on the figure refers to the size of the affected area, and the lower right hand number refers to the importance or severity of the impact (magnitude and importance, respectively). In the example, the number "10" means that the air quality will be affected over the entire study area due to trucking, and the number "1" means that the impact will be negligible. If, for example, the numbers were reversed, then a number "1" in the upper left hand corner would indicate that the affected area would be limited to GAFB only, but the number "10" in the lower right hand corner would indicate a clear or "crisis" type of impact. A box around the two numbers on any table indicates that the impact of that specific action is one of concern if the alternative is implemented.

The key at the bottom of Chart 1 applies to Charts 2 through 6 also. The values given in the tables are based on available evidence and data. The reader is encouraged to derive his own values using the information provided in the main body of the report and the appended material.

Leopold Matrix




Specific Actions (e.g., trucking)
a
b
c
a
Environmental Components (e.g., air quality)
b
10
1

GASOHOL/ETHANOL PLANT

Environmental Impacts

Climate--The predicted water vapor and heat release (emission) rates arising from the operation via holding pond evaporation, cooling tower losses, heated stack gases, etc. should not impact significantly the climate of the GAFB area. However, water vapor released from various process stages may induce local ground fog or surface icing within several hundred feet of the site on cold mornings. Given the conclusion of no significant impact from a 30,000 ton-per-year CO_2 emission level arising from a proposed coal gasification project in the southwestern United States (WESCO EIS 1976), the venting rate from the GAFB pilot plant should have negligible impacts on the area's climate.

Air Quality--The potential sources of atmospheric pollution include 1) intermittent fugitive dust and motor vehicle (e.g., diesel, rail, or truck engine) emissions during both the construction and operational phases of the project, 2) gaseous and particulate matter from the boiler where the characteristics and amounts of such substances are determined by the means of generating the process steam, 3) intermittent vapor emissions arising from filling the gasoline bulk storage tanks and from gasohol production/storage activities, and 4) largely in-plant odors arising from thin stillage concentration or brewer's grains storage/processing. A semi-quantitative estimate of such pollutant emissions is given in Table C-1.

The intermittent and diffuse nature of the diesel and gasoline-fueled vehicle emissions occurring over the project's lifetime will probably not constitute a significant impact on present air quality conditions. Non-boiler particulate emissions could be reduced to about 15 percent of those given in Table C-1 via the installation of filter pads on the climate control vent system, especially in the presence of a low-pressure dust cyclone (Sax 1975) or baghouse dust collection system (Danielson 1973).

The gasoline hydrocarbon emission level (given in Table C-2) is largely applicable to the case of splash-filled storage from overhead loading into tanks that utilize simple vapor displacement control technology. The estimated quantity will occur only one or two days per month when gasoline is transferred from tanker truck to tankage. Ordinarily (but not always) the hydrocarbon concentration found in escaping vapors ranges from 30 to 50 percent by volume and consists of those gasoline fractions varying from methane through hexane, as shown in Table C-2.

With regard to gasohol processing, vapor losses may be about 0.15 percent by volume (i.e., approximately 23 gallons daily production at worst) and will

Table C-1.--Approximate Daily (24 hour) Emission Levels of Air Pollutants Arising from the Pilot-Scale Ethanol Plant (Without Pollution Control)

Process Phase	NO_x	SO_x	Pollutants (in pounds) Particulates	HC	CO	Aldehydes	Water Vapo
Construction							
Railroad Haulage [a]	0.56	0.49	0.19	0.37	0.52	0.08	NC.
Truck Freighting [b]	4.90	0.36	0.17	0.05	3.00	0.08	NC.
Passenger Vehicles [c]	1.24	0.05	0.41	3.05	19.44	0.15	NC.
Operation							
Grain/Straw Processing	Negl.	Negl.	38.4 [d]	Negl.	Negl.	Negl.	2060 [e]
Cooking/Mashing	Negl.	Negl.	Tr.	Negl.	Negl.	Negl.	1.2 [f]
Fermentation	Negl.	Negl.	Negl.	Tr. [g]	Negl.	Tr. [g]	Negl [h]
Beer Well	Negl.	Negl.	Negl.	Tr. [g]	Negl.	Tr.	Tr.
Distillation	Negl.	Negl.	Negl.	Tr.	Negl.	Tr.	2856 [i]
Product Drying	Negl.	Negl.	Tr.	Tr. [g]	Negl.	Tr. [g]	1000 [j]
Gasohol Blending/ Processing	Negl.	Negl.	Negl.	30.9 [k]	Negl.	Tr. [g]	Tr.
Oil-Fired Steam Generator [l]	63.9	335.8	0.15	1.3	0.05	0.62	NC.
Lignite-Fired Steam Generator [m]	60.5	40.4	7.4	1.1	6.7	0.02	NC.
Straw-Fired Steam Generator [n]	48.5	35.6	252.1	0.88	5.4	0.016	NC.

NOTES:
- a) Calculated from Table 13-21 in Energy Alternatives, assuming a haulage of 80 tons of equipment, etc., from Glasgow, Montana to the GAFB; this transport effort should require no more than a few days to complete.
- b) Calculated from the above table, assuming a haulage of 40 tons of equipment by diesel truck from Glasgow, Montana to the GAFB; this transport effort should require less than 10 work days to complete.
- c) Calculated from Table 13-25 in Energy Alternatives, assuming 12 vehicles, each traveling an average of 36 miles per day; these emission levels should not change significantly from those levels expected during the operational phase.
- d) Assumes a maximum loss of materials of .10 percent w/w for both straw and grain.
- e) Assumes a maximum loss of 5 percent w/w from straw or grain prior to usage.
- f) Assumes a requirement of 15 gallons steam/water vapor per bushel of grain and a loss of 0.10 percent from the system.

Table C-1.--Approximate Daily (24 hour) Emission Levels of Air Pollutants Arising from the Pilot-Scale Ethanol Plant (Without Pollution Control)

(Continued)

NOTES:

g) Measured as a variable mixture of potentially noxious gases and/or odors.

h) Assumed to occur during normal pumping to the still preheater or from the fermenter tanks plus vapors arising during inspection or repair; measured as in note g).

i) Assume 45°F input, 140 psig steam trap pressure and a 70 percent increase in water weight (relative to input); applied nomograph, Figure 10-18 (Trap Test Chart), p. 9-233 in Higgins and Marrow (1977) to arrive at a 5.6 percent loss figure.

j) See Figure 1 in text - assumes 0.5 ton moisture loss from thin stillage concentration and brewer's grain handling, drying, etc.

k) Calculated using the data contained in M. J. Dougherty, A. W. Percy, E. L. Wiseman, and F. W. Lord, Gasoline Vapor Control at Service Stations, pp. 249-259 in R. L. Byers *et al's* *Dispersion and Control of Atmospheric Emissions: New Energy-Source Pollution Potential*, American Institute of Chemical Engineers, Symposium Series 165, Volume 73, 1977.

l) Calculated from Table 12-4, Energy Alternatives assuming 9.11 X 10^5 Btu/day input (i.e., 1.15 X 10^5 Btu/80 lbs steam, 2200 lbs. steam/hour for 24 hours/day and oil to steam conversion efficiency of 80 percent). Assume ash content of 0.12 percent w/w and sulfur content of 2.3 percent w/w.

m) Calculated from Table 12-4 in *Energy Alternatives*, using the same assumptions except a 90 percent conversion efficiency from coal to steam; coal HHV assumed to be 6900 Btu/lb. as received, with sulfur content average of 0.6 percent as received and total content converted to SO_2.

n) Assumes NO_x level is comparative to that from the Lignite-fired system; straw HHV assumed to be 7900 Btu/lb. dry weight and 5800 Btu/lb. as received. Sulfur content assumed to be about 0.17 percent sulfur (and completed converted to SO_2) and an ash content of 4.82 percent, (with 1/2 w/w escaping through the stack). Straw to steam conversion efficiency assumed to be approximately 95 percent. The emission rates for HC, CO, and aldehydes has been assumed to be only 80 percent of those expected for the Lignite coal because of differences in their expected, respective, chemical composition(s).

NC. Not calculated
Tr. Trace

Table C-2.--Analysis of Vapors From the Bulk Loading of Gasoline from Tank Trucks*

Fraction	Percent by Volume	Percent by Weight
Air	58.1	37.6
Hydrocarbon		
Propane	0.6	0.6
Iso-Butane	2.9	3.8
Butene	3.2	4.0
N-Butane	17.4	22.5
Iso-Pentane	7.7	12.4
Pentene	5.1	8.0
N-Pentane	2.0	3.1
Hexane	3.0	8.0
	100.0	100.0

*Taken from Danielson, Table 171, p. 655.

include (in addition to the above substances), isobutanol, n-propanol, plus various esters, aldehydes, and other low molecular weight substances due to the fusel oil fraction.

Application of any one of the non-natural gas steam generation options will most likely require the installation of particulate and sulfur oxide control technologies in order to meet existing federal or state pollution (emission) control standards (Table C-3).

These values represent approximately 1.1 times the expected levels accumulated over a 24-hour per day operation; the relatively low rates of pollutant emissions should be controlled legally and safely via appropriately designed and scaled equipment.

Water Quantity--The GAFB water supply system is more than adequate to meet the predicted requirements for pilot plant operation. However, an expansion of plant activity by an order of magnitude (i.e., to about 16,800 gallon per day alcohol production) may require the retrofit of the present capacity delivery to Building No. 945.

Water Quality--The characteristics and quantities of substances present in the plant's liquid effluents will vary with the type of fuel used and type of pollution control applied to the potential air emissions (Table C-4). The values presented in Table C-4 appear lower than expected, yet probably indicate that the general magnitude of the problem can be managed adequately via bio-oxidation process in the ash/sludge handling pond adjacent to the plant. These substances, plus small amounts of inorganic materials from the boiler blowdown will enter the pond at a rate of about 900 gallons per day (assuming a four percent by volume blowdown factor from the boiler and one percent by volume blowdown from the cooling tower[s]). The possible discrepancy between organics and BOD/COD levels could be eliminated upon onset of monitoring the actual operation.

Solid Waste--Moderate amounts of packaging materials, wood, metal, wire, and plumbing scrap will be generated by the construction of a gasohol production facility.

The demineralizer plant, using raw Missouri River water (FEA 1975) will produce about 63.5 pounds-per-day of sludge in the course of preparing the boiler feed water (Babcock and Wilcox 1975) assuming that the hot water heating option is not implemented. Pollution control activities could produce spent air conditioner (dust control) filters plus ash slurry and scrubber sludge as shown in Table C-5.

The calculations in Table C-5 are based on a limestone scrubber system. There are alternative technologies available, including magnesium hydroxide scrubbing and a citrate scrubber process. NO_x and SO_2 can be removed simultaneously.

Table C-3.--Predicted Pollutant Emission (in pounds/10^6 Btu) for the Various Potential Steam Generation Systems for the 1680 GPD Pilot-Scale Ethanol Plant

	Pollutant		
Steam Generation Option	SO_2 a)	NO_2 b)	Particulate(s) c)
Coal-Fired (Lignite)	44.3	66.4	14.7
No. 6 fuel Oil-Fired	368.6	70.2	0.16
Natural Gas-Fired	0.03	35.8	0.01
Wheat Straw-Fired	39.1	53.2	276.7

a) Federal and state coal standard of 1.20 and 2.0 lbs/10^6 Btu, respectively;
b) Federal standard of 0.70 lbs/10^6 Btu (no state standard);
c) Federal standard of 0.10 lbs/10^6 Btu and state standard of 0.60 lbs/10^6 Btu for both existing and new equipment rated under 10 million Btu input/hour.

Table C-4.--Predicted Levels of Water Pollutants Expected for an Uncontrolled Effluent Release Scenario - 1680 GPD Pilot Plant [a]

Pollutants (pounds per day)

Fuel Type	Acids	Bases	PO_4	NO_3	TDS	SS	Organics	BOD	COD
Lignite Coal	0.05	Ukn. [b]	Ukn.	Ukn.	0.01	0.01	0.005	U [c]	U
Fuel Oil (No.6)	0.002	NC	0.001	NC	0.11	0.37	0.04	0.002	NC
Natural Gas	0.002	NC	0.001	NC	0.12	0.45	0.04	0.002	NC
Straw	Ukn.	Ukn.	Ukn.	Ukn.	Ukn.	Ukn.	Ukn.	Ukn.	Ukn.

[a] Calculated using the same assumptions in Table 32, in addition to the factors found in Table 12-4, pp. 12-18 to 12-20 in Energy Alternatives;

[b] Ukn. = unknown;

[c] NC = not calculated.

PO_4 = Phosphate Ion

No_3 = Nitrate Ion

TDS = Total Dissolved Solids

SS = Suspended Solids

BOD = Biological Oxygen Demand

COD = Chemical Oxygen Demand

Table C-5.--Projected Daily Solid Waste Yields from Air Pollution Control Equipment at the 1680-GPD Pilot Plant (pounds)

Fuel Process	Ash Slurry [a]	Scrubber Sludge [b]
Lignite Coal	14.8	107.8
No. 6 Fuel Oil	0.3	896.6
Natural Gas	0.02	0.07 [c]
Straw	506.7	95.0

[a] Input valves taken from Table C-3, with the above values calculated by assuming a 2:1 fly ash - bottom ash ratio and the fly ash slurry being 2:1 water:ash by weight for all fuel systems.

[b] Assuming 75 percent control efficiency, with the products being a 1:1 hydrated mixture of calcium sulfate and calcium sulfite; initial SO_2 values taken from Table C-3.

[c] Assuming a maximum total sulfur content of 10 grains per 100 scf (communication from Mr. John Robertson, Montana Power Company [Butte], December 4, 1978); and an HHV of 1012 Btu/ft.^{3} at 60°F (15.5°C), 14,696 psia (760 mm) with a 95 percent heat to steam conversion efficiency.

Land Use--In addition to hanger #945, the envisioned operation will require the following facilities: a grain-dumping pit with associated extension of existing rail trackage; a solid water/blowdown holding pond; a mechanical draft cooling unit; a southward extension of the hanger wall to encompass the passive solar thin-stillage concentration tank; and the gasohol/gasoline bulk storage complex. The estimated total area required is about 0.21 acres. Such utilization of the presently existing flat, disturbed grassland(s) would constitute a slightly beneficial use of the existing land area.

The off-site extraction/production of fossil fuel or biomass resources for pilot plant steam generation could impact land use patterns elsehwere. A rough estimate of the magnitude of such changes is given in Section 3 of Appendix E.

As the 1680 gallon per day pilot plant will utilize about 641 bushels per day (or the yield from about 9385 acres per year), the level of crop usage for ethanol production should have negligible adverse or possible beneficial impact on the present agricultural activities of the county. If the residue figure estimated by Patrick J. Starr, et al. is utilized, then slightly less than six percent of the cropland area designated for ethanol feed stock needs to be harvested for the generation of process steam (see Appendix E, Section 3).

Soils--Approximately 0.21 acres (at least) of disturbed grassland adjacent to the proposed plant site will be removed through the project's duration. The loss of this small area should not constitute a significant impact on the base's soil regime.

Although the largely Scobey-Phillips-Thoeny soil association is usually well drained (through the upper horizon), the presence of a moderately impermeable clay subsoil prevents rapid percolation through the till into the underlying Flaxville Gravels (FEA 1975). Properly designed and constructed gasoline/gasohol bulk storage and holding pond facilities should constitute only small potential for contamination of the local groundwater system.

Vegetation--The envisioned vegetation impacts, listed below in decreasing order of importance include 1) the loss of approximately 0.21 acres of disturbed grassland community due to site preparation requirements, 2) intermittent and diffuse impact on the overall area's range/plains and riparian communities from the increased population's recreational activities, and 3) potentially adverse physiological response (in selected sensitive species) to the long-term exposure to absorbed trace elements or phytotoxic gases arising from the coal- or oil-fired steam plant. It is possible that careful field monitoring of the existing plant community types would show some changes in composition (i.e., species present) of function (i.e., biomass production versus increased trace element loading realtionships) well into the project's lifetime. However, such potential impact(s) would most probably be negligible compared to existing stress conditions and activities.

Given the intended scale of operation, no significant impacts are expected on nearby ranching or cropping operations.

Wildlife/Grazing Stock--Implementation of the project could induce increased but presumably negligible wildlife mortalities via 1) railroad, automobile, or truck collisions, 2) accidental drownings in or poisioning by the waste effluent holding pond, or 3) through increased hunting pressure. The cumulative effects of exposure to toxic trace elements or gases (e.g., SO_X, NO_X, HF) on populations residing nearby the proposed operation is unknown. If a coal-fired steam plant is utilized, an indirect effect may arise through distribution of a member of an endangered species (i.e., blackfooted ferret) or its critical habitat.

Worker/Public Health and Safety--During the course of normal operations, workers could be (potentially) exposed to the following in-plant hazards or annoyances, listed in approximate decreasing order of importance: 1) leaks in the superheated water or pressurized, saturated steam lines, 2) hydrocarbon vapor/fume emissions from ethanol feedstock processing or alcogas-gasoline blending/ storage operations, 3) particulate emissions arising from grain/straw storage-transfer-milling processes or escaping fly or bottom ash from the furnace, 4) combined odors (i.e., largely organic gaseous substances) released during thin stillage concentration, brewer's grain dehydration, grain storage, etc., 5) excessive noise levels arising from the steam generation system (e.g., miller/stoker on furnace, steam lines), motor-driven conveyors or pumps, product or feedstock handling/processing, etc., 6) gaseous emissions from the fermenter vessels (e.g., CO_2 pockets, ethanol-organic fumes) or SO_X/NO_X/fused-ring hydrocarbon emissions associated with the boiler/air pollution control equipment, 7) falls arising from slippery footing, misuse of ladders, 8) electric shock from malfunctioning equipment during inspection or repair, 9) exposure to grease, oils, lubricants, and 10) exposure to laboratory testing reagents for product/quality control monitoring, especially if mishandled.

In order to mitigate, if not eliminate, such problems as above as well as prevent gross system malfunctions (with the possible consequences of fires, explosions, major spills, etc.), the plant will be designed by and constructed under the supervision of a reputable engineering firm and an associated hardware supply company.

The process (steam generation and ethanol) components will be designed and constructed in accordance with American Society of Mechanical Engineers (ASME) and American Society of Testing Materials requirements and will be installed in accordance with ASME, American Society of Heating, Refrigeration, and Air-Conditioning Engineering, and American Society of Agricultrual Engineer regulations. Special care must be given to the gasoline/gasohol bulk storage-transfer facility design (Hopf 1975). An overall industrial disaster control program (Sax 1975) should be developed from the final engineering design; hopefully, an effective routine maintenance program (Higgins 1977) will avoid disaster. It is suggested that an extensive literature review and/or laboratory analytical program be developed soon after project initiation.

Assuming that the gasohol plant is designed, constructed, and operated properly, the overall operation should not constitute any significant risk or pose any significant hazard to the resident on-base human population.

Social Impacts

Agency Response--Valley Resource Council endorsed this alternative and suggested that "an enclosed livestock feedlot should be enlarged upon to include conversion of a safeguard area to pig palaces as proposed by a local rancher."

The Corps of Engineers stated that the impacts of this alternative would be favorable.

The Glasgow Chief of Police supported this re-use (see letters in Appendix E, Section 4).

The Tribal Council at the Fort Peck Reservation did not object to this alternative. Mountain Bell stated that no change in its work force would be required by this alternative.

Valley County Development Council supported this alternative. The Department of Highways said that no significant impact on the highway system would result from this alternative.

The Bureau of Indian Affairs stated that further assessment would be required for this alternative.

The Glasgow postmaster stated that no major problems would result from this alternative.

Valley Electric Coop Incorporated supported part of this alternative but expressed concern about possible air pollution.

Survey Approval--Sixty-nine percent of those surveyed said they would like a gasohol plant in Valley County. Twenty-four percent said they were opposed to it, and seven percent said they did not know.

Labor Force--An adequate work force exists in Valley County for most aspects of the construction phase as well as a good portion of the skill requirements of the operational phase.

Crime--Minor increases in criminal activity may occur if new employees are also new residents of Valley County. Civil adjudication would probably increase, but no additional personnel would be required.

Welfare/Unemployment--The extent of the impact would be dependent on the number of new residents of Valley County. Some unemployment would result from the various phases occurring from construction to operation. Job service capabilities are currently adequate to handle these possibilities.

Medical Facilities--Impact is dependent on the number of new residents involved in the facility.

Education--Facilities are adequate to handle the number of employees under consideration.

Streets and Roads--Adequate road systems currently exist to handle potential population increases resulting from this alternative.

Business--Business impact would be affected by changes in population and would vary commensurately.

Religion--Adequate facilities and personnel currently exist to handle the potential population increases.

Summary--Social impacts would be minimal. Survey and agency approval is favorable.

MAGNITUDE / IMPORTANCE

Proposed Actions	Habitat Ground Cover Modification	Alter Groundwater/Drainage	Industrial Sites/Buildings	Railroad Retrofit	Transmission/Pipe Lines	Barriers/Fencing	Dams/Impoundments	Earth Moving/Site Preparation	Surface/Subsurface Excavation	Energy (Steam) Generation	Mineral Processing (Off-Site)	Chemical Industry (Odors)	Product Storage	Strip Mine Reclamation (Off-Site)	Increase Railroad Traffic	Increase Auto Traffic	Increase Truck Traffic	Increase Community Traffic	Landfill/Disposal	Spoils/Ash Disposal	Cooling Water Discharge	Liquid Effluent Discharge	Oxidation Ponds	Gas/Particulate Emissions	Trace Element Emissions	Weed Control	Explosion/Fires	Spills and Leaks	Operational Failure	Population	Fertilization Application	Domestic Discharges
Conditions																																
---ENVIRONMENTAL IMPACTS---																																
Fossil Fuel Resources (Coal, Oil, Natural Gas)	1/2	2/5								**2/7**	2/1																					
Construction Materials (Sand/Gravel)	1/2	1/1	1/1	1/1												1/1	1/1															
Soils	1/2		1/2	1/1	1/1	1/1	1/2	1/1	1/1					1/1					1/2					1/3	**1/4**		1/5	**1/4**				
Landform	1/1	1/2	1/1					1/1						1/1					1/1								1/2					
Surface Water Quantity		2/3					1/2			1/1	1/1	1/1		1/1						1/1		1/1										
Underground Water Quantity		2/3												1/1																		
Surface Water Quality	1/3	1/2	1/3	1/1	1/1			1/1	1/1		1/1			1/1	1/1				1/2			1/1		1/1	1/2	1/1	1/1	**1/4**	1/2			
Underground Water Quality		1/2	1/2								1/1			1/1					1/3									**1/4**	1/3			
Air Quality	1/3		1/4	1/1	1/1			1/1	1/1	**1/4**	1/1	**1/5**	1/3	1/1	2/1	2/1	2/1		1/3	1/1			1/2	1/3	**1/4**	1/1	**2/6**	1/3	1/3			
Climate							1/1			1/1											1/2		1/2	1/1								
Noise			1/3	1/4	1/1			1/3	1/1	1/1	1/1	1/1	1/1	1/1	2/2	2/1	2/1		1/1	1/1	1/1					1/1	**2/8**		1/3			
Erosion/Deposition Solution/Leaching	2/4	1/2			1/1			1/1	1/1					1/1					1/3	**1/6**	1/2	1/1			1/2	1/1		1/4				
Native Flora	1/2	1/2	1/2	1/1	1/1		1/1	1/2	1/1	1/2	1/1	1/2	1/1	1/1					1/1	1/1	1/1		1/1	1/2	1/3	1/4	1/4	1/3				
Native Fauna	2/5	1/1	1/1	1/1		1/1	1/1	1/1		1/1		1/1	1/1	1/1	2/1	2/1	2/1		1/1	1/1	1/1		1/2	1/3	1/3	1/4	1/4	1/3				
Endangered Species	**1/10**	1/5	1/1	1/1												2/3	2/3							1/1	1/1							
Grazing/Ranching	1/3	1/1								1/1	1/1	1/1	1/1	1/2	1/1	1/1	1/1							1/1	1/1		1/2					
Recreation		1/1				1/1										2/2								1/1								
Scenic Views/Vistas	1/2	1/3	1/1					1/1		1/2		1/1	1/1	1/2					1/1	1/1	1/1	1/1	1/1	1/2			1/8					
Historical/Archeological	1/1	1/2	1/1					1/2					1/1			1/1			1/1													
Existing Man-Made Facilities		1/1	1/4+	1/6+	1/3+	1/1	1/1	1/2+	1/1	1/3+		1/5+	1/5+	1/1	1/2+	1/1	1/2	2/1	1/3	1/3	1/1	1/1	1/1	1/2	1/1	1/1	**1/10**	1/4	1/3			
---SOCIAL IMPACTS---																																
Streets/Roads																1/1	1/1													1/1		
Garbage/Landfill			1/2																1/2											1/1		1/1
Water Sewage			1/1																											1/1		1/1
Fire Protection			1/1																											1/1		
Utilities			1/1																											1/1		
Housing Availability																														1/1		
Police Activity																1/1	1/1													1/1		
Civil/Legal																1/1	1/1													1/1		
Taxes/Land Values			1/1																											1/1		
Agriculture																															**7/5**	
Real Estate																														1/1		
Retail Business																														1/1		
Service Business																														1/1		
Health and Safety																														1/3		
Medical/Dental																														1/5		

Chart C-1.--Gasohol/Ethanol Plant Impacts (cumulative)

KEY: See Coal Gasification Impacts.

⧄ indicates significant areas of impact.

MODULAR HOUSING FABRICATION CENTER

Environmental Impacts

Climate--No adverse or beneficial impact is projected, even if the high production scenario is implemented.

Air Quality--Gaseous and particulate emissions from automobile/truck and railroad traffic will result from the implementation of the low production scenario. The cumulative impact on air quality should be negligible. Increased traffic resulting from the implementation of the middle production scenario may produce measurable but minor pollutant impacts in the immediate vicinity of the operation(s). These impacts will become more severe, although probably legally tolerable, with the development of the high production scenario. In all cases, the impact should be negligible beyond the perimeter of the GAFB site.

Water Quantity--The present water delivery services at GAFB will be adequate to meet the demand of all production scenarios.

Water Quality--The production of modular homes produces minimal effluent discharge (paint residuals), utilizes little, if any, process water, and involves minimal emissions (wood particulate from the power tools). Effluents and domestic sewage, including that produced by new area residents utilizing the GAFB housing area, will be handled adequately by the existing sewage system and treatement facility. Potential groundwater contamination could result if sewage lines are not maintained properly.

Solid Wastes--Table C-6 summarizes probable solid waste impacts by process phase utilizing the Leopold assessment methodology. It is anticipated that some of these impacts will approximate a geometrical progression as the complexity and scale of production increases.

Minor structural modifications to the GAFB facilities proposed for production may result in small quantities of metal and wood wastes. These can be stored until production begins.

Many of the materials listed in Table C-6 can be used by GAFB residents; the remainder can be incinerated in a waste heat boiler system (with an expected heat content range of 4600 to 5500 Btu per pound) transferred to a local sanitary landfill site.

Table C-6.--Summary of Solid Waste Production and Projected Impacts

Process Phase	Types of Wastes	Low	Middle	High
Materials Receiving	--Packaging materials (e.g., lumber, cardboard, styrofoam, metal banding, and paper)	1/3[b]	2/4	3/6
Warehousing	--Remnants of packaging materials	1/1	1/2	2/2
Framing/Roofing	--Wood stud and plywood scraps, sawdust, galvanized metal scraps, roofing tile and felt scraps	1/1	1/3	2/5
Plumbing/Electrical	--Wiring and plumbing scraps	1/1	1/2	1/3
Finishing	--Dry wall (gypsum board) and carpeting scraps	1/1	1/2	1/3
Stock/Shipment	--Packaging scraps	1/1	1/2	1/4

[a] magnitude/importance

[b] the magnitude (numerator) represents the projected areal extent (scale) of the given impact, e.g. a "1" valve signifies about 25 ft.^{2}, a "2" signifies about 50 ft.^{2}, etc.'; the importance value (denominator) represents the projected intensity or severity of impact, ranging from negligible ("1") to intolerable ("10") if not managed in accordance with all pertinent federal, state, or local solid waste handling requirements.

Soils--It is expected that scattered local compaction or surface disruption of soil profile or structure will result along possible spurline retrofit and highway repair sites as a result of heavy equipment operation during the construction phase. There will be some local soil disturbance during the erection of a security fence around the project site. No significant impacts are expected during the production phase.

Vegetation--Vegetation communities in the vicinity of heavy equipment operation will be heavily disrupted. However, most of the impacted sites should revegetate naturally and reach an ecologically stable (baseline) condition within several growing seasons. It is anticipated that there will be some deterioration of rangelands and wildlife habitat resulting from increased traffic along GAFB trails. Even with the maximum projected population increase, this should only be a minor impact.

The flora within several hundred feet of the transfer (loading and unloading) operations may show slightly elevated heavy metals content as a result of cumulative exposure to gasoline and/or diesel engine emissions. The biological significance of such trace element loading should be of a minor nature/consequence when viewed at the level of the GAFB ecosystem.

Wildlife--There will be some disturbance of bird and mammal species resulting from noise and general activity generated at the construction and warehouse sites. Sharptailed grouse and waterfowl are the game species most likely to be encountered near the site. A few mortalities are expected as a result of collision with transport vehicles and competition between displaced species and resident populations on lands already near carrying capacity. The fencing of the railroad spur to GAFB using a "sheep-tight" fence could easily free antelope movements across the railroad spur line although antelope migrations do not occur during average winters and the spur line is relatively short. This impact should not be considered as significant.

Montana Department of Fish and Game statistics indicate that a resident human population increase of 928 will probably add about 110 game bird or big game hunters, or both, to the area. The populations of game species should be able to withstand this increased hunting pressure with no adverse effects. Endangered or threatened species are protected by law and should not be adversely impacted.

Health and Safety--The facility will be constructed and operated to meet all federal, state, and local worker health and safety requirements. Protective equipment and forced draft ventilation in noisy, dusty, or hazardous areas should mitigate any adverse impacts.

Social Impacts

Agency Response--The Department of Fish and Game responded that this alternative (in the low-production scenario) would have a negligible environmental impact at GAFB but would not require review by the Department.

The Valley Resource Council stated that it would fully endorse an energy-efficient modular housing industry.

The Corps of Engineers approved this alternative (see Section 4 of Appendix E).

The Tribal Council of the Fort Peck Reservation did not object to this alternative.

The Department of Highways expressed concern about the transportation of modular housing and requested more specific information to determine impacts.

Mountain Bell stated that no change in work force would be required by this alternative.

Valley County Development Council supported this alternative.

Valley Electric Coop Incorporated supports this alternative.

The Glasgow postmaster stated that no major problems would result from this alternative.

Survey Approval--Eighty-two percent of those people surveyed stated that they would like a solar house manufacturer in Valley County. Seven percent disagreed, and ten percent said they did not know.

Labor Force--Considering the low production scenario, there currently exists an adequate work force in Valley County to meet these requirements. The middle production scenario includes 170 employees. The current labor supply in Valley County may be able to meet most, or all, of these requirements. The high production scenario will require about 400 employees. The current labor supply in Valley County would not meet these needs, but enough personnel could be acquired in the regional five-county area.

Crime--The low production scenario would have a negligible impact on criminal activities. The middle production scenario may have a minor impact, and a slightly higher rate of activity could possibly result from the high production alternative. These considerations are based on population increases as if no significant change would occur if those employees were currently Valley County residents. Some increase in civil cases could be expected in the judicial facilities, but no additional personnel would be required with the possible exception of an assistant youth probation officer.

Welfare/Unemployment--The low production scenario would have little or no impact on the existing organizations that deal with this area. Some affect on these agencies may be realized as 170 employees (middle-level scenario) move into the county. Four hundred employees would definitely affect these agencies. The Job Service currently has adequate personnel to handle these amounts.

Medical Facilities--There currently exists a considerable amount of public dissatisfaction with existing medical facilities in Valley County. The low production scenario would not alleviate this problem, nor would it make it significantly worse. The middle production scenario may bring in enough people on a long-term basis to force an increase in services so the situation may be initially undesirable but improvements could be forthcoming. The same affect could be predicted for the high-scale scenario.

Education--Facilities are adequate in Valley County to handle these potential increases.

Streets and Roads--Virtually no affect on streets and roads would be expected from the population increase of the low production scenario. Adequate facilities exist for handling the number of people involved in the middle production scenario. Some increase in traffic congestion would result from the numbers of people in the high production scenario using the services of Glasgow. Impacts are dependent on the number of new residents.

Business--Minor impacts (if any, as these may all be local people) would be experienced by an additional 40 employees in the community. One hundred and seventy employees would result in considerable business increases (if they were new to the community) in the various services, and 400 more employees in the county would produce significant increases in the business community.

Religion--Forty employees would produce a very minor increase in religious activity. One hundred and seventy employees would have a somewhat greater impact, but this could be adequately accommodated, as would 400 new employees.

Summary--Social impacts range from minimal to moderate depending on production rate. Most of the agencies support this alternative.

MAGNITUDE / IMPORTANCE

Proposed Actions Conditions	Industrial Sites/Buildings	Railroad Retrofit	Barriers/Fencing	Site Preparation	Excavation	Product Storage	Increase Rail Traffic	Increase Auto Traffic	Increase Truck Traffic	Landfill Disposal	Gas/Particulate Emission	Weed Control	Population	Recreational Structures	Trails	Domestic Liquid Wastes
---ENVIRONMENTAL IMPACTS---																
Soils	1/1-2	1/1	1/1	1*/3	1*/3	1/2-3				1/1-3	1*/2	1/1-2				
Landform				1*/1	1*/1					1*/2						
Surface Water Quantity	1/1-2															
Surface Water Quality	1/1-2	1/1		1/1-2	1*/2		1/1			1/1-3	1*/1	1/1-2				
Air Quality	1/1-2	1/1		1*/2	1*/2		2/1-3	2/1-3	2/1-3	1/1-3	1/1-4	1/1-2				
Noise	1/1-4	1/4		1/4*	1/4*	1/1-4	2/1-3	2/1-3	2/1-3	1/1-2		1/1				
Erosion/Leaching (Groundwater)	1/1	1/1		1/1-2	1/1-2					1/1-4		1/1				
Native Flora	1/1	1/1		1*/2	1*/2	1*/2				1/1-2	1*/2	1/1-3				
Native Fauna	1/1		1/1	1*/1	1*/1		1/1-2	2/1-2	1/1-3	1/1-2	1*/2	1/1-4				
Recreation			1/1					2*/2-4								
Scenic Views/Vistas				1*/2	1*/1	1*/1				1/1-3	1*/2					
Historical/Archaeological				1*/2	1*/3			1/1-2		1/1-3						
Existing Man-Made Facilities	1*/2-5	1*/3	1/1	1*/4	1*/2	1*/1	1*/2	1/1-3	1/1-2	1/1-5	1*/2	1*/1				
---SOCIAL IMPACTS---																
Streets/Roads								1-2/1-3	1-2/1-3				1-2/1-3			
Garbage/Landfill	1/1-3									1/1-4			1-2/1-2			1/1-2
Water/Sewage	1/1-2												1/2*			1/1-2
Fire Protection	1/2												1/3			
Utilities	1/1												1/2*			
Housing Availability													1/1*			
Police Activity								1-3/2-5	1-3/1-3				1-3/3-7	1/1*		
Civil/Legal								1/3*	1/3*				1-3/3-7			
Taxes/Land Values	1/1-3												1-3/1-3			
Welfare/Social Security													1-3/1-3			
Education													1-2/1-2			
Religion													2*/2*			
Unemployment													1/5*			
Media (TV, Radio)													1/1*			
Agriculture								1/1*	1/1*				1/1			
Real Estate													1/2-5			
Retail Business								1/1	1/1				1/1-5			
Service Business								1/1	1/1				1/1-5			
Hunting													1-6/1-3		3/3*	
Fishing													1-4/1-3		3/3*	
Hiking													1-4/1-3		3/3*	
Health and Safety								3/2-4	3/2-4				1/5-7			
Medical/Dental													1/1-7			

Chart C-2.--Modular Housing Fabrication Center Impacts (cumulative)

KEY: *Indicates high production scenario only.
(See Coal Gasification Impacts)
☐ -Indicates significant areas of impact

12-000-016-C

RAIL CAR REPAIR FACILITY

Environmental Impacts

Climate--No adverse or beneficial impact is projected for this re-use alternative.

Air Quality--The operation of heavy earth moving equipment could result in a locally intense but diffuse impact (see Section 3 of Appendix E). Using these projections, a small degradation of air quality is expected within the immediate area of the plant, decreasing to insignificant levels at the base perimeter. Operational-phase emission(s) impacts are expected to be negligible given adequate plant and pollution control system design; violation of federal and/or state air quality standards appears unlikely.

Water Quantity--The existing water system at GAFB appears adequate to meet plant and infrastructural needs.

Water Quality--The railcar repair facility should have negligible impact on the GAFB aquatic environment. The outlined activity has minimal effluent discharge and utilizes little, if any, process water. Domestic sewage (and possibly process effluents) can be adequately handled by the existing GAFB municipal sewage disposal system. Hydrocarbon (e.g., grease and oil) drippings from rolling stock and similar materials from repair shop machinery could cause a BOD/COD and/or trace element surface or groundwater contamination problem if improperly regulated or disposed. Close regulation/monitoring of these effluents and possible use of an impervious bio-oxidation/settling pond should effectively eliminate the potential for adverse impacts.

Increased utilization of the local fishery may result in some decline in the quality of fishing (in terms of catch rates and average catch size) and may result in a deterioration of the aesthetic quality of the area if debris and litter also increase at the site. Since the trout fishery of the "Trout-pond" is maintained by the stocking of rainbow trout by the Montana Department of Fish and Game, it probably could withstand considerably more fishing pressure than would result from the development of the railcar repair facility. Porcupine Creek would probably receive little additional fishing pressure with the limited population increase projected at GAFB.

Solid Waste--Operation of the proposed facility would result in the production of solid wastes including 1) oily metallic shavings/ribbons, particles and irregular-shaped scraps; 2) small, light-weight discards (e.g., broken hand tools, trucksprings, airbrake components, empty oil/hydrocarbon containers); 3) rags, wood/cardboard packaging-shipping materials, sawdust and woodscraps, and administrative wastepaper; 4) pollution control wet scrubber/cyclone wastes, spent solvent/particulate air filters; and 5) heavy wastes (e.g., carbody side walls, underframes, couplers, etc.). Combustible items could be disposed of in a central multi-chamber (air quality standards permitting) or via local municipal trash collection services. Metallic wastes could be stored and then periodically removed to a salvage/reclamation facility. Liquid wastes could be handled adequately through use of an evaporation/chemical treatment pond.

Soils--The construction of yard trackage, highway repair activities, and outdoor salvage/storage efforts could disrupt the soil structure or profile by compaction or ripping effects. The impacts could be locally severe but pose no significant threat to the base or regional ecosystems.

Vegetation--The only potential impact on the vegetation of the area would be a deterioration of the rangelands and wildlife habitat resulting from increased traffic along trails around GAFB. Because of the relatively small population increase associated with this re-use (50-120 employees; 400 persons), this should constitute a minor impact.

Wildlife--The railcar repair facility, as described, should have little if any impact on the wildlife of the GAFB area. Potential exists for disturbance of some game bird or mammal species resulting from noise and vibration of rail traffic and repair facility operation. Such a disturbance would be minor since few observations of game species were made near the proposed repair facility site, and wildlife species generally adapt to the presence of noise disturbances after a short time following their initiation. Game populations in the GAFB area could easily accommodate any additional hunting pressure resulting from the population increase associated with the facility.

The greatest potential wildlife impact is the possible interruption of antelope migration caused by particular types of spur line fencing. The relatively short length of the spur line and the fact that migrations of significant numbers of animals usually occur only in the severe winters minimizes this impact.

Social Impacts

Agency Response--The Corps of Engineers approved of this alternative.

Valley Resource Council gave its full endorsement of this re-use.

The Department of Fish and Game felt there would be a minor to moderate impact by the temporary construction force associated with this alternative.

The Glasgow Chief of Police felt this alternative would benefit the community (see letters in Section 4 of Appendix E).

The Tribal Council at the Fort Peck Reservation did not object to this re-use scenario.

Valley County Development Council stated that adequate facilities are available to handle this development.

The Department of Highways said there will be no significant impact on the highway system from this alternative.

Mountain Bell reports no work force change will be required from this re-use.

Valley Electric Coop Incorporated supported this alternative.

The Glasgow postmaster stated that no major problem would result from this alternative.

Survey Approval--Seventy-three percent of those surveyed said they would be in favor of a rail car repair facility. Sixteen percent of the sample stated they were opposed, and eleven percent said they did not know.

Labor Force--An adequate work force exists in Valley County for most aspects of the construction phase of the facility as well as a good portion of the skill requirements of the operational phase.

Crime--Minor increases in criminal activity may occur if new employees are also new residents of Valley County. Civil adjudication would probably increase, but no additional personnel would be required.

Welfare/Unemployment--The extent of the impact would be dependent on the number of new residents of Valley County. Some unemployment would result from the various phases occurring from construction to operation. Job service capabilities are currently adequate to handle these possibilities.

Medical Facilities--Impact is dependent on the number of new residents involved in the facility.

Education--Facilities are adequate to handle the number of employees under consideration.

Streets And Roads--Adequate road systems currently exist to handle potential population increases resulting from this alternative.

Business--Business impact would be affected by changes in population increase. Increases would be similar to the middle level production scenario of the modular housing alternative.

Religion--Adequate facilities and personnel currently exist to handle these potential population increases.

Summary--Social impacts would be minimal. Survey and agency approval is favorable.

MAGNITUDE / IMPORTANCE

Proposed Actions	Habitat/Ground Cover Modifications	Alter Groundwater/Drainage (Surface)	Industrial Sites/Buildings	Railroad Reconstruction	Barriers/Fencing	Site Preparation	Excavation	Product Storage	Increase Rail Traffic	Increase Auto Traffic	Increase Truck Traffic	Landfill Disposal	Liquid Effluent Discharge(s)	Gas/Particulate Emissions	Weed Control	Spills and Leaks	Population	Domestic Liquid Wastes	Recreational Structures	Trails
Conditions																				
---ENVIRONMENTAL IMPACTS---																				
Soils	1/3	1/2	1/2	2/4	1/1	1/3	1/3					1/2		1/3		1/4				
Landform		1/1		1/2								1/1								
Surface Water Quantity			1/2										1/1							
Underground Water Quantity						1/2														
Surface Water Quality	1/2	1/1	1/1	1/2		1/2			1/2			1/2	1/1	1/1	1/1	$\boxed{1/4}$				
Underground Water Quality												1/2				1 4				
Air Quality		1/1	$\boxed{2/4}$	1/2		1/2	1/1	1/2	2/3	2/2	2/1	1/2		1/3	1/1	1/2				
Noise		1/1	$\boxed{1/6}$	1/4		$\boxed{1/5}$	1/3	$\boxed{1/4}$	$\boxed{2/6}$	2/1	2/2	1/1			1/1					
Erosion/Leaching (Groundwater)	1/2	1/1	1/1	1/3		1/2			1/1			1/3	1/2	1/1	1/1	$\boxed{1/4}$				
Native Flora	1/3	1/1	1/1	1/3		1/2	1/2					1/1		1/2	1/2	1/3				
Native Fauna	1/2		1/2	1/2	1/1	1/1	1/1		1/3	2/1	2/2	1/1		1/3	1/2	1/2				
Recreation					1/1					$\boxed{2/3}$										
Scenic Views/Vistas	1/1		1/1	1/2		1/2	1/1	1/1				1/1	1/1	1/2						
Historical/Archaeological	1/1	1/1	1/1	1/4		1/2	1/3			1/1		1/1								
Existing Man-Made Facilities		1/2	$\boxed{1/2+}$	$\boxed{1/5+}$	1/1	1/4	1/1	1/2	1/2+	1/2	1/1	1/3	1/2	1/2	1/1	1/3				
---SOCIAL IMPACTS---																				
Streets/Roads										1/1	1/1						1/1			
Garbage/Landfill			1/2									1/2	1/1				1/1	1/1		
Water/Sewage			1/1														1/1	1/1		
Fire Protection			1/1														1/1			
Utilities			1/1														1/1			
Housing Availability																	1/1			
Police Activity										1/1	1/1						1/1		1/1	
Civil/Legal										1/1	1/1						1/1			
Taxes/Land Values			1/1														1/1			
Welfare/Social Security																	1/1			
Education																	1/1			
Religion																	1/1			
Unemployment																	1/1			
Media (TV, Padio)																	1/1			
Real Estate																	1/1			
Retail Business																	1/1			
Service Business																	1/1			
Hunting																	1/1			1/1
Fishing																	1/1			1/1
Hiking																	1/1			1/1
Health and Safety																	1/3			
Medical/Dental																	1/5			

Chart C-3.--Rail Car Repair Facility Impacts (cumulative)

KEY: See Coal Gasification Impacts.

$\boxed{/}$ —Indicates significant areas of impact.

12-000-017-C

WIND ELECTRIC POWER PRODUCTION AND WIND TURBINE GENERATOR MANUFACTURING FACILITY

Environmental Impacts

Climate--No adverse or beneficial impacts are projected for a pilot-scale wind farm and manufacturing facility. A large-scale wind farm will alter microclimatic conditions by increasing the roughness of the earth's surface in the vicinity of the facility. This could affect both the distribution of wind in the vertical direction (gradient) and the details of wind swirl patterns at the ground (Howell 1978). Local patterns of temperature, precipitation, snow drifting, and evaporation might be modified.

Air Quality--Gaseous and particulate emissions from automobile and railroad traffic will result from the siting of wind turbines and the operation of a manufacturing facility. The cumulative impact from these sources should be negligible. The assembly of wind generator components may involve gaseous and/or particulate emissions uncharacterized at this time because of the unknown production process scenario.

Water Quantity--The present water delivery services at GAFB will be adequate.

Water Quality--The production of wind turbines may involve minimal effluent discharge (e.g., paint and metal working residual). The siting of wind generators could result in localized siltation and erosion in the immediate vicinity of the wind farm, especially if inadequate site reclamation/restoration occurs. Process effluents and domestic sewage, including that produced by new area residents utilizing the GAFB housing area, will probably be handled adequately by the existing sewage system and treatment facility.

Increased fishing pressure will have a negligible impact if the implementation of this alternative occurs.

Solid Wastes--Minor structural modifications to the GAFB facilities proposed for production may result in small quantitites of metal and wood wastes. These can be salvaged by local area residents or transferred to a local sanitary landfill site.

Soils--Compaction or surface disruption of the soil profile (and structure) will result from the erection of wind turbines within the wind farm boundaries. Other localized soil disturbance could result from spur line and highway repair, tower access/maintenance road construction, etc.

Vegetation--Vegetative communities in the vicinity of the wind farm will be slightly disrupted by the erection of wind generator/towers. These areas should revegetate naturally. A minor deterioration of rangelands and wildlife habitat may result from increased traffic along GAFB trails or wind farm activities (e.g., right-of-way maintenance/clearing).

Wildlife--The actual construction of the wind generator/towers would be the greatest disturbance factor. Siting the turbines on a high grassland bench may disrupt a few scattered antelope and a few songbird species. Raptors or predators also utilize these areas. The operating generators could be a potential hazard to migratory bird species during poor weather conditions (low visibility and low ceiling), either day or night. Unless the wind farm was constructed in an area where grainfields and stockponds were common, there should be little water fowl activity in the vicinity of the generators, thus making large mortality incidents improbable.

Sharp-tailed grouse and waterfowl are the game species most likely to be in close proximity to the manufacturing facilities, and any disturbance of them from operation of the facilities should be very minor. Increased hunting pressure resulting from the human population increase (approximately 102) is another potential impact.

Noise--A wind machine generates sound power in two modes (Howell 1978). The first mode is produced by the blade separating the air surrounding it, while the second mode results from the interaction of the blade and the air to produce unsteady forces (see Section 3 of Appendix E). A third source of sound is from the supporting tower. Most of the high-frequency noise spectrum will be absorbed at the boundaries of the wind farm. Infrasound, low-pitched air-pressure waves exemplified by the rumble of a city as heard from the top of a building,is generated by wind turbines. It is virtually inaudible and is not expected to have any environmental significance.

Television and Radio--Television (video channel) reception interference arises from the specular reflection of the electromagnetic signal from metal wind generator blades acting singly. This mirror-like reflection does not interfere with FM reception or with the audio channel of television.

Several mitigating measures are possible, including the use of non-metallic blades. This will probably be unnecessary in the Glasgow area, however, because there are no transmitting antennas in the vicinity. The translator station serving Glasgow and GAFB should lie outside the region of interference, although this is subject to empirical verification.

Health and Safety--The wind generator manufacturing facility and wind farm will be constructed to meet all federal, state, and local worker health and safety requirements. Protective equipment will be provided to mitigate noise, dust, or otherwise potentially hazardous conditions (e.g., rotor failure/disintegration).

Aesthetic/Visual Impacts--Until the wind turbine generator engineering design/scaling and plot plan for the proposed wind farm are finalized, a detailed assessment of the visual impacts arising from the implementation of this re-use scenario is difficult to prepare. The shape of the machine(s), tower type (e.g., steel, truss, concrete, etc.), unit spacing, and the geographical setting of the operation will elicit different responses from polled individuals (ERDA on Wind Energy, 1977). Wallace G. Howell (1978) contends that a large scale (i.e., unit or spaced) operation would generate similar reactions to those provided by large dams/reservoirs, nonurban housing aggregate, high voltage electrical transmission lines, etc. It is thus suggested that prior to initiation of full-scale efforts to implement this concept, a statistically significant cross-section and portion of the County's white and Indian populations be polled on this subject.

Social Impacts

Agency Response--The Glasgow Chief of Police felt this alternative should benefit the community.

The Department of Fish and Game stated that minor to moderate impacts could be expected during the construction phase of this alternative.

The Valley Resource Council gave its full endorsement to this re-use scenario.

The Corps of Engineers felt there would be a favorable impact from this alternative (see Section 4 of Appendix E).

The Tribal Council at the Fort Peck Reservation did not object to this alternative.

The Department of Highways said this alternative should not have a significant impact on the highway system.

Valley County Development Council supported this alternative.

Valley Electric Coop Incorporated supports the concepts, but expressed reservation about its economic viability.

The Glasgow postmaster did not foresee any major problems with this alternative.

Survey Approval--Eighty-four percent of those surveyed said they would like a manufacturer of wind generators to locate in Valley County. Seven percent were opposed and eight percent said they did not know.

Labor Force--An adequate work force exists in Valley County for most aspects of the continuation phase of the facility as well as a good portion of the skill requirements of the operational phase. It is expected that about one-half of the labor force needed for the operation would need to have prior experience in a similar facility, and it is anticipated that these people will be brought in from outside the county.

Crime--Minor increases in criminal activity may occur if new employees are also new residents of Valley County. Civil adjudication would probably increase but no additional personnel would be required.

Welfare/Unemployment--The extent of the impact would be dependent on the number of new residents of Valley County. Some unemployment would result from the various phases occurring from construction to operation. Job service capabilities are currently adequate to handle these possibilities.

Medical Facilities--Impact is dependent on the number of new residents involved in the facility (see earlier discussions).

Education--Facilities are adequate to handle the number of employees under consideration.

Streets and Roads--Adequate road systems currently exist to handle potential population increases resulting from this alternative.

Business--The impact on local business would be favorable and result in significant increase of retail sales to the labor force that would be needed to support the facility operations.

Religion--Adequate facilities and personnel currently exist to handle these potential populations increases.

Summary--Social impacts would be minimal. Survey and agency approval is favorable.

MAGNITUDE / IMPORTANCE

Proposed Actions Conditions	Habitat/Ground Cover Modification	Industrial Sites/Building	Transmission/Pipe Lines	Barriers/Fencing	Site Preparation	Excavation	Energy Generation	Product Storage	Increase Auto Traffic	Increase Truck Traffic	Landfill Disposal	Liquid Effluent Discharge	Gas/Particulate Emissions	Weed Control	Operational Failure	Population	Recreational Structures	Trails
---ENVIRONMENTAL IMPACTS---																		
Construction Materials (Sand/Gravel)	2/3	1/1	1/1		2/3	2/3			2/2	2/2			2/1					
Soils	2/3	3/2	2/2	2/1	3/4	2/3					1/2		1/2		1/2			
Landform	2/2				2/1	2/2					1/1							
Surface Water Quantity		1/2			1/1							1/2			1/1			
Surface Water Quality	2/4	1/3	3/1		1/3	2/4					1/2	1/4	1/1	1/1	1/3			
Air Quality	1/1	1/2	1/1		2/3	1/1			2/2	3/2	1/2		1 4	1/1	1 4			
Climate		3/2					3/1						1/1					
Noise (Including Electromagnetic Effects)		2/5	1/2		3/3	2/3	2/3		2/1	3/1	1/1			1/1	1/3			
Erosion/Leaching (Groundwater)	2/4	3/1	3/1		3/4	2/4					1/3	1/3	1/3	1/1	1/3			
Native Flora	2/2	3/2	2/2		3/2	2/2					1/1		1/3	1/3	1/3			
Native Fauna	2/3	3/3	3/1	2/2	3/3	2/3	3/3		3/1	3/1	1/1		1/3	1/3	1/3			
Endangered Species	1/5	1/4	3/4		1/5	1/5	3/5		3/5	3/1			1/3	1/4	1/4			
Recreation				1/2			3/3		3/3						1/3			
Scenic Views/Vistas	1/1	3/6	3/4		1/3	1/2	3/6				1/1	1/1	1/1		1/2			
Historical/Archaeological	2/2	3/3	3/3		3/3	3/3	3/3		1/1		1/1				1/1			
Existing Man-Made Facilities	1/1	3/3	3/1	1/1	3/1	1/2	3/3		1/2	1/2	1/3	1/3	1/3	1/1	1/10			
---SOCIAL IMPACTS---																		
Streets/Roads									1/1	1/1						1/1		
Garbage/Landfill		1/2									1/2	1/1				1/1		
Water/Sewage		1/1										1/1				1/1		
Fire Protection		1/1														1/1		
Utilities		1/1														1/1		
Housing Availability																1/1		
Police Activity									1/1	1/1						1/1	1/1	
Civil/Legal									1/1	1/1						1/1		
Taxes/Land Values		1/1														1/1		
Welfare/Social Security																1/1		
Education																1/1		
Religion																1/1		
Unemployment																1/1		
Media (TV, Radio)																1/1		
Real Estate																1/1		
Retail Business																1/1		
Service Business																1/1		
Hunting																1/1		1/1
Fishing																1/1		1/1
Hiking																1/1		1/1
Health and Safety																1/3		
Medical/Dental																1/5		

Chart C-4.--Wind Electric Power Production and Wind Turbine Generator Manufacturing Facility Impacts (cumulative)

KEY: See Coal Gasification Impacts.

⧄ -Indicates significant areas of impact.

12-000-018-C

COAL GASIFICATION FACILITY

Environmental Impacts

Climate--While some minor microclimatic influences will occur at the immediate site (e.g., through moisture disposal from the heat exchangers, heat from the scrubbed flue gases, or cloud/ice formation downwind of the wet cooling towers on cold mornings), no significant impacts are anticipated given the scale of the proposed plant. The area's dry, continental-type climate should mitigate the site-specific impacts. Impacts of CO_2 emissions from the proposed GAFB facility through the creation of a "greenhouse effect" (in which hot air is trapped, creating greenhouse-like atmospheric conditions) should be negligible based on operations of a similar plant in New Mexico (USDI 1976).

Air Quality - Mine Site--The primary sources of air pollution emissions at the mine site would be from diesel equipment (e.g., hauling truacks, railroad engines) fugitive dust from mine operations, and smoke from occasional spoil-pile fires.

Data contained in the EIS's for the WESCO and El Paso SNG projects were used to generate estimates of emissions for the diesel-powered systems used for transporting the operations (see Table C-7).

These emissions will be released at a sufficiently low rate and be dispersed over a sufficiently large area so that impacts on the ambient air quality should be intermittent and limited to the areas immediately adjacent to haulage paths (road/rail).

Estimated unit train coal transport impacts during mine operation are presented in Table C-8.

Estimates of approximate overall emissions resulting from light duty personnel and company vehicles are presented in Section 3 of Appendix E.

Increased traffic could cause biologically significant increases in the heavy metal content of roadside plant and soil materials (Lagerwerff and Specht 1970). It is suggested that grazing stock be fenced from road right-of-way areas. Sources of fugitive dust include coal stripping/loading/hauling activities, reclamation operations (e.g., re-contour grading) and from previously graded-seeded reclamation plots. Detailed dust abatement procedures can be determined once the background (natural) vs. best available dust production estimate levels are compared and evaluated.

Spontaneous combustion during mining, resulting from the mixing of fractured coal into the overburden, may contribute to the local level of air-borne pollutants. Such fires will be smothered out (with additional overburden) before they become a noticeable problem.

Air Quality - Gasification Plant The burning of coal fines for process heat and steam gasification of coal in the Lurgi pressure vessels will result in the release of numerous inorganic contaminants which, by law, may be controlled. Methods for handling gaseous stream pollutants are given in Table C-9.

Table C-7.--Expected Haul Vehicle Emissions from the Mining Operations Using a Truck/Railroad Haulage System[a]

Contaminant	Emissions (pounds per day) minimum[b]	Emissions (pounds per day) average[c]
Total Particulates	4.4	38.6
Sulfur Dioxide	9.2	84.0
Hydrocarbons	12.6	110.2
Nitrogen Oxides	126.0	1104.8
Aldehydes (HCHO)	1.0	8.9
Organic Acids	1.0	8.9
Carbon Monoxide	85.1	670.7

[a] With railroad at peak operation, the total combined truck and rail engine consumption is reduced to 60% of the levels required for truck only transport. In-mine coal transport via conveyor systems (assuming ≤ 2 mile haul distance) could probably halve the above emissions rates.

[b] Scaled down to meet the needs calculated for the coal gasification plant at GAFB, using WESCO/El Paso type data.

[c] Estimated from Northwest-type coal operation data in Table 1-25, pp. 1-61 in Energy Alternatives, taken to be the lowest emission levels that could realistically be expected from such an operation. Estimated from H. Shaw and E. M. Magee, Evaluation of ... Lurgi Processes, July 1974.

Sources: Adopted from Table 3-1, p. 3-3 in WESCO EIS, and Table 1-25, p. 1-61 in Energy Alternatives.

Table C-8.--Air Pollutant Residuals for Coal Transportation by Unit Train[a]

Contaminant	Emissions (tons per 12.5 rail miles per year)
Particulates	2467.2
Nitrogen Oxides	278.0
Sulfur Oxides	241.5
Hydrocarbons	185.3
Carbon Monoxide	260.2
Aldehydes	40.8

[a] 100 car unit train, each hauling up to 100 tons of "Northwest Coal," e.g. 6928 coal delivered at a rate to satisfy the 224251 tpd minimum plant requirements.

Source: Energy Alternatives, Table 1-56, p. 1-127.

* Btu/lb. HH Run-of-Mine

Table C-9.--Pollutant Handling and Estimated Emission Rates for the Lurgi/Ammonia Plant Operations

Contaminant	Handling/Mitigation Process(es)	Emission Rate (lbs/hr)	
		Average[a]	BACT[b]
Sulfur Dioxide	Clause plant conversion to elemental sulfur using high H_2S streams; Stretford-Holmes plant for dilute sulfur streams.	413.8	144.6
Nitrogen Oxides	Regulation of air:fuel ratios, proper boiler design	1890.8	1118.2
Hydrocarbons	Cryogenic Scrubbing	562.3	25.8
Particulates	Electrostatic Precipitators	51.8	11.7
Carbonyl Sulfide	Hydrolyzed in the Benfield acid gas removal step to H_2S, then treated as above.	4.3	------[c]
Fluoride(ine)- Gaseous & Particulate Forms	Electrostatic Precipitators/ Water Spray/Quenching	8×10^{-4}	------[c]
Mercury	Electrostatic Precipitators/ Water Spray/Quenching	2.75×10^{-2}	------[c]
Ammonia	Electrostatic Precipitators/ Water Spray/Quenching	0.78[d]	------[c]
Product Gases	Proper Storage/Transfer Design	1.68[d]	------[c]
Benzo(a)-pyrene	Proper Boiler Design	2.7×10^{-3}[e]	------[c]

[a] Adjusted for differences between WESCO Navajo-type coal and Montana Circle West/Burlington Northern-type coal; plant assumed to be operating at 100% capacity.

[b] Adaptation of coefficients (i.e., per $\times 10^{12}$Btu input) from Tables 1-46, 1-47 in Energy Alternatives with the discussion on Best Available Control Technologies (BACT) given in Control of Emissions from Lurgi Coal Gasification Plants, U. S. EPA - 450/2-28-012, March, 1978.

[c] Data not available to make this calculation.

[d] H. Shaw and E. M. Magee, Evaluation of Pollution Control in Fossil Fuel Conversion Processes: Lurgi; EPA-650/2-74-009-C, July, 1974, pp. 33.

[e] S. Miller, Environmental Impacts....Coal Development, OWRC, Washington, D.C., 1974, pp. 94; assumes conventional dry or wet furnace; projected value increases by an order of magnitude if a cyclone-fired furnace is utilized.

Atmospheric emissions from the Lurgi emergency flare-off system (see Section 3 of Appendix E) include CO_2, water vapor, and varying amounts of SO_x, NO_x, and inorganic particulate matter (including trace elements). The rapid release of SO_2 during total emergency flare-off might induce ambient SO_2 levels to approach or exceed the federal three-hour secondary standard (0.5 ppm) causing discomfort to plant personnel in the area, especially under inversion-type atmospheric conditions.

Uncertainties in WESCO vs. GAFB engineering design (e.g., stack height/diameter and number, gas exit velocities/temperatures, etc.) will not allow presentation of estimated individual stack or flare emission rates. Thus, the lack of these critical parameters disallows dispersion modeling/ground-level pollutant concentration calculations beyond the preliminary commentary by Brelsford, et al. (FEA 1975). However, comparison of the above estimates with those for Colstrip (DNRC 1974) is somewhat disconcerting if the Lurgi plant is to be sited adjacent to potential PSD I air quality type land (see Section 3 of Appendix E).

The values presented in Table 13 are based on assumptions that can be easily challenged. Subtle modifications of sophisticated SO_2 scrubbing (or particulate electrostatic precipitation) technologies and/or solvent-refined coal procedures could reduce SO_x emissions considerably from the auxilary steam-electric plant. It also seems probable that NO_x, ammonia, HCN, or cyanate emissions would increase if process wastewater is incinerated rather than treated (as proposed) at the bio-oxidation facility.

The plant will be designed so that most particulate matter will be removed before venting of gases. Fine particles and/or SO_2 molecules may escape, resulting in a light haze over the plant area. Clear air and an unrestricted view as aesthetic resources may be intermittently reduced once the plant becomes operational.

Water Quantity--The 11,500 maximum acre feet/year usage by the proposed mine/gasification facility would increase the present estimated surface water (6.92 million acre-feet per year) usage from 8.70 to 8.85 percent of the (total) available resource. Assuming a doubling of in-state usage of the available water supply (i.e., after adjustments have been made for yearly and seasonal variations) for irrigation or municipal consumption, there should be sufficient water remaining to operate the facility. Increased agricultural usage, expanded thermal power generation downstream, or Montana regulations that give agricultural water needs priority over those for industry could severely deplete the supply during low-flow (late fall/early winter) periods.

Past studies of water use in Valley County reveal that the volume of claimed water rights is considerably greater than the flow rate of the main stem of the Missouri River (FEA 1975). Consequently, rigorous adjudication proceedings would probably be necessary to establish gasification needs as a decreed beneficial water use under the state's Water Resources Act (Section 89-101.1 et seq., R.C.M. 1947).

The capacity of the Flaxville gravel aquifer, near the base, is not accurately known (FEA 1975); values one-tenth the maximum of 100 gallons per minute (gpm) are commonly reported (Patton 1978). The deeper Judith River artesian aquifer commonly yields up to 40 gpm, with a known maximum of 420 gpm (FEA 1975). It is unlikely that more than two percent of the plant water requirements can be met by groundwater flow. In the absence of extensive hydrogeological analysis of the base and adjacent environments, such waters should be utilized only under extreme (emergency) situations so as to prevent possible irreversible alterations in groundwater characteristics from occurring.

Water Quality--The diversion of such a small volume of surface water for use in the mine/plant operations should have a negligible impact on natural temperature fluctuations. If a surface diversion reservoir (e.g., Ranney-type collection system) is constructed off the main flow pattern for either mine or Lurgi plant water supply, the removal of clear (largely sediment-free) water will cause a slight increase in suspended solids immediately downstream of the reservoir via stream degradation. If such a diversion is not implemented the dissolved/suspended materials removed at the Lurgi facility's water treatment plant would have to be either stored in adjacent evaporation ponds or possibly mixed with other plant solid wastes for ultimate disposal. Finally, the water withdrawl could slightly increase the salt concentrations of downstream water during low flow periods. A quantitative estimate of the potential impacts (e.g., reduced crop yields and soil structural changes) arising from elevated salinity levels cannot be defined at present. No significant changes in the river's natural levels of dissolved oxygen, nutrients (i.e., nitrate, sulfate, phosphate), heavy metal concentrations, or background radioactivity levels are expected to result from the diversion process. If the increase in the general population of the mine/plant area is so rapid that lagoons or septic tanks are implemented prior to construction of adequate regional sewage treatment facilities, there is a possible problem of elevated levels of fecal coliform (and other enteric microbes), plant/algae nutrients, detergents and metals and biocides (e.g., herbicides, pesticides).

An estimate of mine-induced impacts on local surface water quality, if uncontrolled, is presented in Table C-10.

Unfortunately, potential contamination of surface waters as a result of surface erosion sources or groundwater contamination resulting from coal/spoil piles or gasification ash leachates that infiltrate into a particular aquifer cannot be quantified at this time. Such concern could be mitigated by implementing a surface station/test well monitoring system to perform water quality monitoring through the baseline, operational, and post-operational phases of the project (Berndt 1975).

The wastewater effluent discharge from the Lurgi facility is largely derived from a combination of sanitary/domestic sewage, raw water/recycle water treatment, gasification processes and reactions and cooling tower blowdown. Estimated characterizations of the wastewater effluent for the overall plant without sulfur controls operating and sulfur recovery effluent streams are given in Tables C-11 and C-12, respectively.

Solid Wastes--Estimated land areas required and solid wastes generated during the overall operation are presented by process component in Table C-13.

The estimated land area and solid waste generation rate for the gasification/ammonia plant are 525 acres and 1267 dry tons per day, respectively (MTC 1976). According to an environmental assessment prepared by Dravo, ash and slag will be disposed of by landfill in compliance with all pertinent federal and state regulations. Assuming that an 1850 ton-per-day waste loading is equivalent to the daily municipal refuse of about 640,000 people (Energy Alternatives 1975), the proposed facility will generate about 62 percent of Montana's daily solid waste loading. For this reason, it may be more sensible to make the proposed operation of a mine-mouth type so that the solid wastes can be economically disposed of nearby. An alternative to mine-mouth disposal is to slowly fill a lined, 349-acre pond about 20-feet deep over the course of the conversion plant's operation lifetime (OWRC 1974).

Table C-10.--Estimated Residuals for Mine Operation by Process Component--Controlled and Uncontrolled Scenarios

Component	Uncontrolled Rate	Controlled Rate[a]
Soil/Surface distrurbances resulting from in-mine haulage by diesel truck (suspended solids). Beneficiation via coal cleaning and washing:	2196.5 tpd[b]	0
Acids[c]	1.1 - 17.2 tpd	0
Total Dissolved Solids[c]	10.4 - 16.0 tpd	0
Suspended Solids[c]	20.0 -236.6 tpd	0
Waste Wash Water[d]	3.72×10^7 gpd	-
Reclamation-suspended solids from runoff (assume 4 year reclamation period).	7.62 tpy · acre[e]	∿ 0

Sources:

a Assumes collection of the pollutants via catchment ditches, storm runoff drains, etc., and transferred to impervious (lined) settling or evapo-oxidation ponds where the chemistry of the effluent may be adjusted to immobilize (e.g., via precipitation) or eliminate (via oxidation to inert substances) the potential water pollutants. The processed supernatant would be recycled to in-mine uses, e.g., coal beneficiation, road dust suppression, etc.

b Calculated from data in table 1-25, p-61 in Energy Alternatives.

c Calculated from the Northwestern coal mining scenario, table 1-27, pp. 1-65, 1-66, in Energy Alternatives.

d Assumes 1700 gpd (Energy Alternatives, pp. 1-67) input with 97.5% pass-through in processing 22425 tpd coal.

e Assumes 2.54 tpy · are suspended solids per inch of runoff; assumes runoff of 3 inches per year at mine site.

Table C-11.--Estimated Composition of the Wastewater Effluent from a Lurgi Plant without Sulfur Controls

Parameter	Before Treatment[a]	After Treatment[b] (in mg/ℓ)	lb/day input[c]
BOD$_5$	1100	≤ 30	326.6
COD	3150	≤ 60	935.2
Ammonia (as N)	350	≤ 270	104.0
Phenols	80	≤ 0.001	23.8
Fatty Acids	2250	≤ 20	668.0
Oil and Grease	40	≤ 10	11.9
Total Dissolved Solids	3750	≤ 200	1113.4
Total Suspended Solids	100	≤ 10	29.7
Cyanide Ion	0.1	~ 0	0.03
Thiolyante Ion	20	~ 0	5.9
Sulfide Ion	1400 (maximum)	1.4	42.5
Sulfates	30	≤ 10	8.9
pH range	—	6.6 - 8.6	—

Sources: a Taken from base plant valves in table 6.7, pp. 6-11 in U. S. EPA Control of Emissions from Lurgi Coal Gasification Plants, EPA-450/2-78-012, March 1978.

b At point of exit from the water treatment process; although the effluent could conceivably be "clean enough" to be disposed of via municipal sewage system, it probably will be recycled into plant operations.

c Scaled down from expected Lurgi output from the 250 American Natural Gas's proposed plant near Beulah, North Dakota; assumes negligible influences arising from the approximately 4% difference in ROM HHV.

Table C-12.--Approximate Composition of the Liquid Waste Stream from the Stretford Process Unit (re: sulfur controls applied)

Component	Weight (Percent)
Sodium carbonate	0.47
Sodium anthraquinone disulfonate	0.07
Sodium meta-vanadate	0.03
Sodium citrate	0.03
Sodium thiosulfate	0.60
Sodium thiocyanide	0.60
Water	98.20
	100.00

Source: U. S. EPA, Control of Emissions from Lurgi Gasification Plants, table 6.8, pp. 6-12.

Table C-13.--An Overview of the Estimated Area Requirements and Solid Wastes Generated by the Proposed Mine When Operated Under Pollution Controlled Conditions

Component/Phase	Solid Wastes (tpy)	Land Requirements	
		Fixed or Initial (acres)	Incremental (acres/yr.)
Coal Stripping/Reclamation	75993.0 [a]	≤10	434.4 [c]
In-Mine Coal Transport			
Diesel Truck	Not Applicable [e]	Included in above figure [b]	31.5 [d]
Mine-Rail (diesel)	Not Applicable [e]	≤10	6 per mile [f]
Electrical Conveyor	Not Applicable [e]	≤ 2	3.6 per mile [f]
Coal Breaking and Sizing	356 [g]	103.8 [g]	---
Coal Cleaning and Washing	13533 [g]	55 [h]	---
Coal Loading and Transport	Not Applicable [e]	40 [h] plus 6 per mile to Lurgi plant	---

[a] Taken from Energy Alternatives (EA), table 1-17, pp. 1-48 to 1-49; assume 5 year reclamation period.

[b] Allocated area for equipment storage, maintenance/repair shops, office, laboratory, etc.

[c] Taken from table 1-17 in EA, assuming 4.18 acres per 10^{12} Btu mined; coalseam assumed to be at least 2.6 feet in thickness (see p. 1-52, EA).

[d] Taken from table 1-25, pp. 1-60 to 1-62 in EA.

[e] Treated as particulate air pollution.

[f] Taken from pp. 1-126 in EA; assumes 55 feet and 30 feet right-of-way for railroad and conveyor systems, respectively.

[g] Taken from table 1-27, pp. 1-65 in EA.

[h] Taken from pp. 1-67 in EA (includes water treatment plant and settling pond).

Soils--Approximately 746 acres of land will be impacted (via complete or partial destruction of local soil profile) during the construction and operation of the physical facilities related to the gasification and coal processing activities. As noted in the wildlife impact section, an additional 2,272 acres will be disturbed per year by the strip-mining per se. Possible impacts include long-term erosion of compacted silty soils, compounded by some measure of defoliation and potential increase in physiochemical contaminants. Reclamation of strip-mined areas should return the soil in these areas approximately to their original state (prior to disruption) providing grazing use factors are controlled, although a permanent loss of productivity is possible. Potential exists for soil fertility changes brought about by increased salinity.

Vegetation--The land-clearing for the siting of the physical facilities (including water pipelines, high voltage transmission lines, and associated right-of-way, access road areas) plus incremental losses caused by coal-mining related activities (including incompletely reclaimed mine areas) would remove a portion of the existing grassland/shrub vegetation at least through the lifetime of the operation (Ross and Hunter 1976). Construction of a diversion/clarification reservoir and/or larger pumping stations adjacent to the Missouri River would destroy a small amount of floodplain (viparian) vegetation. Because of the local, but intense, reduction in biomass production capability (at the impacted site) and the approximate ten percent energy transfer efficiency between trophic levels (McNaughton and Wolf 1973), small reductions in carrying capacity will produce larger reductions in animal population density that is dependent upon it. Unfortunately, mortality estimates as a consequence of this description are not presently calculable.

Cattle production at the mine site will be severely retarded (see Section 3 of Appendix E). Within 10 years after the Lurgi plant's operation approximately 346 animal units per month will be lost with 4,464 acres taken out of production. This level of loss will stabilize for approximately 15 years and then decrease toward the end of the plant's lifetime. Reclamation activities probably will continue for about five years after the shutdown of the operation (see Section 3 of Appendix E). If the mining and reclamation rates are credible and approximately constant, then one can expect a rapid initial loss in rangeland cattle capacity that reaches a plateau somewhere between the fourth and fifth year of operation, this elevated, but nearly constant, level will then exist throughout the remaining lifetime of the operation. The land could possibly be restored to the approximate level of original productivity about five years after cessation of stripping activities.

The ultimate impact is dependent upon the potential of the applied reclamation procedures and how effectively they are implemented and managed. Because of the relatively harsh climatic factors controlling the function of the area's ecosystems, recovery will be slower than for grassland ecosystems situated in a more favorable (wetter) climate. At this time, it is not possible to ascribe an overall "impact index value" to assess the cummulative potential impact arising from the mining activities; this must wait until the proposed mine boundaries have been delineated and detailed environmental (e.g., soil, vegetation, water quality, wildlife) studies have been underway for some time.

The scientific literature contains little data on the long-term effects resulting from the gasification facility's potential levels of gaseous and particulate emissions on the exposed vegetation or associated animal community. (USDI 1977). Section 3 of Appendix E presents an estimate of the overall magnitude and chronology of air pollution related events (e.g., acid rains) that might follow from initiation of gasification/ammonia production activities.

It is predicted that gaseous fumes from the SNG/ammonia production complex will cause gross foliar bleaching, necrosis and/or defoliation to particularly sensitive plant species within the first few years and probably within several miles of the operation. In combination with potential periods of severe climatic episodes (e.g., drought years) and/or grazing pressure stress, this impact could eliminate the most sensitive species or subspecies of the flora adjacent to (or within the zone of impact resulting from) the Lurgi site.

The initial severe/acute impacts would largely be followed by chronic effects resulting from prolonged, but probably intermittent, periods of low-level fumigation during temperature inversions or from the possibly elevated, overall trace element soil deposition rates. It is possible that SO_x or SO_x/NO_x/ trace element synergism effects may reduce productivity (i.e., biomass yields) via subtle changes in certain species' physiology without causing any significant visible pathology.

The acid precipitation/particulate fallout affects can result from the oxidation of gaseous pollutants to their corresponding acids, e.g., sulfurous/sulfuric, nitric, hydrofluoric, etc. Based on case studies of non-ferrous smelters and coal-fired power plants, it is predicted that the Lurgi/ammonia plant's impact zone will originate at the battery limits (i.e., via cooling tower moisture-stack particulate reactions) and extend for up to 40 or 50 miles downwind of the operation unless superior control technology (e.g., greater than 95 percent pollutant capture efficiencies) is utilized. Because the northeastern-most boundary area of the Charles M. Russell National Wildlife Range lies within the predicted "rainout" zone, it is suggested that additional air quality monitoring data be acquired and dispersion modeling be implemented prior to serious consideration of the siting of such a conversion facility at GAFB. Accidental release of stored chemical wastes (e.g., trivalent arsenic, ammonium or cyanide ions, phenol, etc.) or consequences of normal activities (e.g., long-term erosion of compacted silty soils) could create conditions unfavorable for plant biomass production.

Wildlife--The expected impacts of the proposed mine site development include the loss of topographical (i.e., cover and forage) habitat, generating local, but possibly intense, displacement of the various resident animal populations. About 221 acres of wildlife habitat would be lost due to the plant's physical facilities, and the stripping operation would eliminate a maximum of 2,154 acres per year during the mine's lifetime.

The most obvious effect of land clearing would be the displacement or elimination of those terrestrial species (e.g., diurnal ground squirrels, prairie dogs) exposed to the hazards of large-scale earthmoving activities. Data generated for a gasification complex proposed for the Southwestern United States shows a 15 percent reduction in small mammal density within the general mine area. If the reclamation program restores all but the 221 acres in a manner that re-establishes a plant community of at least equal quality and abundance to the preliminary baseline condition, then the impacted fauna could eventually increase to within five percent of the pre-construction carrying capacity (USDI 1976). Finally, loss of river line (e.g., marsh) habitat through the placing of pumping stations, diversion reservoirs, etc. could be significant to those species dependent upon such ecosystems; because such activities would be largely limited to several acres, the displacement or elimination of animal species would be intense and localized.

The effects of noise on wildlife populations are not well documented, although the operations could very well disrupt some aspects of behavior (e.g., intrapopulation auditory signals, predator-prey relationships) within 1/4 mile or so of the noise source (USDI 1976). Mobile mammalian species living within this zone may thus shift their centers of home ranges away from the centers of mining activity. The overall impact will be localized yet spaced sufficiently so as to not constitute a severe problem to the general region's fauna. The clearing of land for mine facility construction and operation could induce local destruction of game bird habitat (e.g., sharptailed grouse breeding grounds) or reduce raptor populations via reduction in prey densities, loss of nesting areas, mortality arising from collisions with power transmission towers, etc. If the human impact is severe enough, the latter bird types might migrate from the area permanently since they tend to habitually nest only at a particular site year after year. Their general absence could be followed by a rapid growth of rodent or lagomorph (e.g., rabbits, hares) populations if uncontrolled by other predators (e.g., coyotes, badgers).

The mine's effect on resident reptile and amphibian population densities cannot be accurately quantified prior to the performance of baseline studies at the then-delineated mine site area. The Lurgi complex-related impacts on such life forms will probably not be biologically significant, especially when viewed from a regional perspective.

It is predicted that activities associated with the construction and operation of the plant and/or mine will cause diffuse, but probably intense, local impacts on wildlife habits or respective habitat. Such consequences would arise through such anthropogenic actions as the construction of special fencing/barriers to delineate utility or railroad rights-of-way or migration patterns of pronghorn antelope. The potential habitat impact(s) can be adequately treated only as a site- and species-specific basis after the detailed plot plans for mine and plant have been prepared.

The mammalian fauna existing within several miles of the gasification facility will be exposed to sulfur compounds (e.g., SO_2/SO_3, particulate sulfate, H_2S), nitrogen oxides, thio and metallic carbonyls, in addition to minute quantities of heavy metal and radioactive trace elements. Potential long-term, low-level exposure of wildlife to emitted pollutants may potentially manifest itself as the project progresses. Adverse reactions could range from acute pulmonary edema arising from intense SO_2 fumigation (USDI 1977) to lessened immunochemical response or unfavorable metabolic reactions resulting from elevated trace element burdens. The elevated mortality or chronic disease rates would probably affect relatively small numbers of given species' populations, even when considering the more sensitive members of the particular species of concern.

The local disruption of the landscape (especially at the mine site) will also adversely affect the resident bird populations (and raptor species in particular) via habitat destruction, noise impacts (possibly producing anomalous behavioral responses), or mortalities arising from improperly designed high voltage lines or collisions with unclearly marked high voltage towers or coal conversion facility vent stacks.

Various toxic materials (e.g., phenols/aromatics, cyanide ion, unionized ammonia, trace elements) could produce a presently undetermined, but possibly adverse, impact to the exposed fauna (i.e., waterfowl, mammals) if accidentally released into local groundwater(s) or surface drainage(s). Furthermore, neither frequency nor consequences of evaporation/waste holding pond visitation by birds or land mammals for resting or drinking purposes can be evaluated. The extent of these impacts must await accurate effluent characterization and respective component concentration calculations.

Endangered, Status Undetermined, and Threatened Species--An official listing of threatened or endangered plant species for Montana does not presently exist. However, a yet-to-be-published study by T. J. Watson, Jr. (1976) concludes that the candidate species are largely limited to areas west of the Continental Divide. Given the limited data, it is cautiously assumed that the coal conversion/mine complex would have little, if any, adverse impact on such types of plant species. However, the scientific and regulatory literature must be followed closely.

Several mammal and a number of bird species inhabiting, or observed in, northeastern Montana are listed as endangered or threatened species; in addition, a small group of bird species remain in an "undetermined status" position, as shown in Table C-14.

The coal mine/conversion complex will be sited in lands that include open plains to shortgrass prairie types of habitat. It is possible that the project area includes prairie dog colonies of sufficient size that can support a resident population of burrowing owls and/or black-footed ferrets. As the ferret is dependent upon the prairie dog, it is of utmost importance to maintain the latter's habitat if the former is to survive. Thus, prior to mine siting, joint surveys should be completed with the USDI's South Dakota Cooperative Wildlife Research Unit to ensure that coal stripping activities do not jeopardize their ferret recovery program's effectiveness in Montana. Diligent surveillance of the potential mine site area for the presence/absence of swift fox and northern rocky mountain wolf critical habitats should occur at least through the baseline monitoring phase of the project. The wolf (Canis lupis irremotus) is not expected to be present in the fauna of northeastern Montana (USDI 1973); however, a female specimen has been spotted and killed in the Glasgow area (Montana Standard, October 22, 1978).

Although no critical habitat apparently exists for whopping cranes in Montana, it is probable that they utilize portions of the Charles M. Russell Wildlife Range as resting stops during their biannual migration to and from Canadian breeding (summer) grounds (Robbins, et al 1978). Consideration for their well being (e.g., disturbance-free, submerged sandbar maintenance) may be of importance in planning mine activities. The osprey and/or peregrine falcon may be affected 1) directly through coal conversion related trace element emissions in a manner analogous to those predicted for the Harry Allen Power Plant in Utah (USDI, 1978) and/or 2) indirectly through the increased probability of exposure to humans along the Fort Peck Reservoir. This is an especially important factor in maintaining the peregrine falcon since, if disturbed/displaced during nesting periods (at traditional sites) they may not re-nest even in nearby areas (USDI 1977).

Health and Safety--The Lurgi/ammonia plant and coal mine will be constructed and operated to meet all federal, state, and local worker health and safety requirements. Protective equipment/systems in noisy, dusty, or otherwise hazardous areas or conditions should mitigate any adverse impact occurring in the overall coal conversion operation (Cohen 1978).

Table C-14.--Rare, Status--Undetermined and Threatened Animal Species Present in Northeastern Montana

Mammals

Common Name[a]	Scientific Name	Status Code[b]
Blackfooted ferret	*Mustela nigripes*	E
Northern swift fox	*Vulpes velox hebes*	E

Birds

Common Name[a]	Scientific Name	Status Code[b]
American prairie falcon	*Falco mexicanus*	T
American osprey	*Pandion haliaetus*	U
Burrowing owl	*Speotyto cunicularia*	U
Ferruginous hawk	*Buteo regalis*	U
Mountain plover	*Eupoda montana*	U
Northern long-billed curlew	*Numenius americanus*	U
Peregrin falcon	*Falco peregrinus*	E
Whooping crane	*Grus americana*	E

[a] Common names taken from FEA I (1975), table 17, pp. 82; zoological nomenclature taken from *Threatened Wildlife of the United States*, USDI, Fish and Wildlife Service, Bureau of Sport Fisheries and Wildlife, Office of Endangered Species and International Activities, U.S. Government Printing Office, 1973 edition.

[b] Explanation of status code: 1) Endangered (E) pertains to those species in imminent danger of extinction (at least in part of their range) as of July 14, 1977 (*Federal Register 42*, (135), 7/14/77, pp. 36420-36431), 2) Threatened (T) refers to those species whose survival requires the mitigation of a variety of factors (e.g., habitat disturbance or over-exploitation/hunting) but not necessarily in danger of extinction, and 3) Undetermined (U) status wherein population/habitat data was inadequate to classify the particular species into the (T) or (E) categories as of July, 1977.

Social Impacts

Agency Response--The Valley Resource Council,(VRC expressed concern about the possible damaging affects of the pollutants on the soil and water of northeastern Montana). Their letter of response expressed concern for the possible strain that various county agencies may experience from such a large influx of people. Another issue VRC expressed apprehension about was possible tax increase that may result from an increase of service costs to handle various social problems. The Valley Resource Council does not endorse this alternative.

The Montana Department of Fish and Game stated they would like to review specific plans that will affect water and coal development, air quality, emission control, law enforcement, recreation development, and waste disposal.

The Glasgow Superintendent of Schools stated that a major expense would be required to open the Junior High School on the base, but this impact could be handled.

This alternative was seen as favorable by the Corps of Engineers and the Chief of Police (see Section 4 of Appendix E).

The Tribal Council at the Fort Peck Reservation said they were concerned about the pollution involved in coal gasification and they did not approve of its implementation.

The Department of Highways expressed concern about the impact this alternative would have in increasing the traffic volume, thus affecting existing traffic patterns.

Mountain Bell expects that no significant work force change would result from this alternative.

Valley County Development Council expressed concern about the affect of a Class I air designation and the effect it would have on the development of this re-use.

The Bureau of Indian Affairs felt that further assessment would be needed for this alternative.

Valley Electric Coop Incorporated supports the concept, but feels it is not feasible because of current state regulations.

The Glasgow postmaster stated that full use of the base housing would require an additional part-time worker and a 1/2-ton delivery vehicle. No other problems are anticipated.

Survey Approval--Forty-seven percent of those surveyed stated they would like a coal gasification plant located in Valley County, 38 percent said they did not want a coal gasification plant in Valley County, and 14 percent said they did not know.

Labor Force--The construction phase will employ 1,200 people the first year, 2,100 to 2,500 the second year, 1,000 the third year, and 350 the following six months.

Initially the mine production phase will employ six supervisors, 16 technicians, two equipment operators, and five construction field support personnel. These figures will increase until, in seven years, there will be 80 supervisors, 25 technicians, 330 equipment operators, and 20 field construction support personnel.

Most of these people would be residents of Montana. Approximately 40 percent would be hired from out of state by the contractor. Based on current employment rates in Valley County, about 100 unemployed residents of the county could expect to find employment with this alternative. Considerable employment potential would exist for minority groups as the contractor would be subject to equal opportunity regulations.

Crime--The increase in population considered in this alternative could have significant increases in criminal activity. Civil caseloads would probably increase for the existing judicial system. An additional assistant probation officer may be needed for the youth probation office.

Welfare/Unemployment--Impacts could be foreseen in these areas as employees are layed off or terminated, and as the construction phase evolves into the operational phase requiring different types of skilled employees.

The Valley County Department of Public Welfare reported that an increase of up to 2,500 construction workers in the county would increase the need for daycare and foster-care facilities. Up to three more social workers, two home attendents, and an electrical worker would be required to handle these increased service needs. Potential increased demands for welfare assistance may require additional eligibility technicians and clerical support (see Section 4 of Appendix E).

Medical Facilities--Many residents of Valley County consider most of the existing medical facilities currently overcrowded. The population increase considered in this alternative would make the existing facilities even more crowded and may result in greater public dissatisfaction, although this extent of impact may force an increase in services.

Education--Existing educational facilities at Glasgow Air Force Base would require some preparation but the Glasgow Superintendent of Schools feels the increase of students could be accommodated.

Streets and Roads--Traffic congestion could be expected to increase in Glasgow. This congestion would probably be no greater than experienced during the operative years of the air base. Some increase on secondary roads would also increase, probably requiring a maintenance increase. Considerable deterioration could be expected from the heavy trucking involved in transporting certain construction materials to the plant from their source.

Business--Very significant impacts would be realized in virtually all aspects of service oriented businesses. Those businesses oriented towards agriculture probably would not experience as great an impact.

Religion--Adequate facilities exist in Valley County to handle potential increases, but additional personnel may have to be acquired in the respective religious organizations.

Summary--Social impacts would be considerable but could be accommodated by the existing agencies. Community support is not completely favorable and several agencies and organizations object to its implementation.

Alternative Summary--Implementation of this re-use scenario will involve the construction and operation of a gasification/ammonia production complex having minimum inherent technological risk and average to above-average production scale flexibility (relative to other potential engineering systems). It is highly probable that the existing water pipeline and railroad delivery systems will have to be upgraded (if not completely replaced) with higher capacity design to handle the anticipated production requirements of these materials. The mine activities will probably lie outside of Valley County and may or may not require a newly-sited extractive operation; in this discussion, a new mine located somewhere within the Weldon-Timber Creek coal field of McCone County was assumed to be the source of coal.

Finally, proper design and layout should mitigate (if not eliminate) any significant interferences arising between present or future levels of regional air traffic and either the mine or gasification complex operations.

MAGNITUDE / IMPORTANCE

Proposed Actions	Habitat/Ground Cover Modification	Alter Ground Water/Drainage (Surface)	Industrial Sites/Buildings	Railroad Construction	Transmission/Pipelines	Barriers/Fencing	Dams/Impoundments	Earth Moving/Site Preparation	Surface/Subsurface Excavation	Energy Generation	Mineral Processing	Chemical Industry	Product Storage	Strip Mine Reclamation	Ground Water Recharge	Increase Railroad Traffic	Increase Automobile Traffic	Increase Truck Traffic	Increase Communication Traffic	Landfill Disposal	Spoils/Ash Management Actions	Cooling Water Discharge	Liquid Effluent Discharge	Oxidation Ponds	Gas./Particulate Emissions	Trace Element Emissions	Weed Control	Explosions/Fire	Spills and Leaks	Operational Failure	Population	Trails	Recreational Structures	Fertilizer Application	Paving	Domestic Discharge(s)
Conditions																																				
---ENVIRONMENTAL IMPACTS---																																				
Mineral Resources	**3/8**	**3/8**								**3/8**		**3/8**																								
Construction Material	1/5	1/5	1/5	1/3	1/1			1/1	1/5																											
Soils	2/5		1/2	1/2	1/5	1/2	1/4	1/5	1/6					**3/8**						1/5		1/1			**7/4**	**3/4**	2/2	1/5	1/5		1/5	1/5	1/5			
Landform	1/3	1/4	1/2	1/1	1/2		1/4	1/5	1/4					**2/8**	1/2					1/3								1/3								
Water/Surface/Quantity		4/5	1/3		2/4		1/3*			**2/6**	1/3	2/6	1/1	2/2	1/5						1/3															
Water/Underground/Quantity		3/5	1/1						1/3	**1/8**				1/3	1/7																					
Water/Surface/Quality	2/5	2/3	2/3	1/2	1/2	1/1	1/2	1/4	1/2	2/6	1/5	2/6	1/1	**2/7**	1/3	1/2				1/4	2/3		**1/6**		4/3	2/3	2/4	1/2	**2/8**	1/5						
Water/Underground/Quality		2/4	1/2						1/3	2 7					**2/7**					**1/5**	**2/7**		**1/6**		2/1	2/2	1/2		**1/7**	1/5						
Air Quality	2/5		1/3	1/1	1/2			1/3	1/2	**4/8**	1/5	1/5	**1/5**	**1/6**		3/1	3/2	2/1		1/3	1/4	1/1		1/3	**5/8**	**4/6**	2/1	**2/6**	2/5	**2/4**						
Climate			1/1				1/1			1/3		1/3										1/2		1/2	2/3											
Noise			2/4	1/5	1/2	1/1		1/6		2/4	1/3	1/3	1/1	1/3		**2/6**	3/2	2/3		1/4	1/2	1/2						1/6		1/6						
Erosion/Deposition/ Solution/Leaching	2/5	2/4			2/3	1/2	1/2	1/3	1/2		**1/6**			2/4						1/3	**1/8**	1/3	1/2			**1/5**										
Native Flora	3/6	1/3	1/2	1/1	1/2	1/1	1/5	1/4	1/3	4/5	1/2	3/5	1/2	2/5						1/3	**1/1**	1/2	1/1		6/3	2/2	1/3	1/6	1/6							
Agricultural Crops	1/5	1/3	1/3		1/3	2/2	1/6	1/5	1/3	**2/5**	1/1	2/4	1/2		1/5						1/1	1/3	1/1		**8/5**	2/3	1/2	1/6	1/6							
Native Fauna	**3/8**	1/2	1/3	1/1	3/3	2/5	1/6	1/4	1/3	2/6	1/3		1/3	2/4	1/3	1/2	3/1	2/2		1/3	1/1	1/2	2/2	1/3	4/4	2/4	1/3	1/6	1/3							
Endangered Species	**1/10**	**1/7**	**1/7**	1/2	1/4	1/5	1/6	1/4	1/4	2/4	1/4	1 6			1/3	1/4	3/5	2/4							**4/8**	**2/8**	1/6	1/6	1/2							
Grazing/Ranching	2/4	1/3	1/1		3/2	2/5	1/5	1/2	1/3	3/5	1/2	1/3	1/2	**1/6**	1/6	1/3	3/2	2/2			1/2	1/1	2/2		**4/6**	2/3	1/1	1/3	1 2							
Recreation	1/2	1/1	1/1			1/3	1/2										3/3		2/2						3/5	1/4										
Scenic Views/Vistas	1/3	1/2	1/5	1/1	3/3	2/3	1/1	1/2	1/3	1/4	1/4	1/3	1/2	2/4			1/2			1/3	1/3	1/3		1/3	2/4			1/8								
Historic/Archaeological Sites	1/1	1/3	1/3	1/1	3/3	1/1	1/5	1/5	1/5	1/1		1/1	1/1				2/2			1/2	1/2			1/3				1/8	1/3							
Existing Man-Made Facilities		1/4	1/2	**1/7***	3/2	3/3	1/5	1/4	1/4	1/3	1/1	1/2	1/1	1/1	1/3	**2/6***	**2/4**	**2/4**	2/2	**1/4**			1/2		**4/5**	2/2	/1	**1/10**	1/5	**1/6**						
---SOCIAL IMPACTS---																																				
Streets/Roads																	3/5	**4/7**							3/2						3/5				2/2	1/3
Garbage/Landfill			1/2																	1/3			1/3								2/3					
Water/Sewage			**4/8**		**4/8**				1/3														1/2								1/3			1/1		
Fire Protection			1/2																												1/3					
Utilities			**3/8**		**4/8**																										1/3					
Housing Availability																															1/1					
Police Activity																	4/5	4/3													**4/7**		2/3			
Civil/Legal																	4/5	3/2													**4/7**					
Taxes/Land Values			2/3						1/2																						3/5					
Welfare/Social Security																															**2/8**					
Medical/Dental																															**2/10**					
Education																															**3/8**					
Religion																															**3/7**					
Unemployment																															**1/7**					
Media (TV News, Radio)																															2/2					
Agriculture																	1/3	1/5													5/5			**10/3**		
Real Estate																															**1/6**				1/1	
Retail Business			1/1														1/1	1/1													**3/8**			**10/2**		
Service Business			1/1														1/1	1/1													**3/8**					
Hunting																															6/4	3/5				
Fishing																															4/3	1/4				
Hiking																															3/1	3/1				
Health and Safety																	3/5	3/4													**1/7**					

Chart C-5.--Coal Gasification Plant Impacts (cumulative, includes mining)

KEY: IMPACT AREA (Upper left number/numerator): 1-3 (GAFB/5280 acres;
4-7 (Valley County/320,000,000 acres);
8-10 (Regional/400,000,000 acres).

IMPACT SEVERITY (Lower right number/numerator): 1-3 (negligible to moderate, no damage); 4-7 (damage possible); 8-10 (clear damage--10 is crisis)

☐ Indicates significant areas of impact

APPENDIX C

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APPENDIX D

ATTITUDINAL SURVEY

ATTITUDINAL SURVEY RESULTS

During the course of this project, an attitudinal survey was conducted to determine the opinions of Valley County residents regarding the five re-use alternatives identified in this effort as feasible for GAFB:

1. Gasahol/Ethanol Plant;
2. Modular Housing Fabrication Center;
3. Rail Car Repair Facility;
4. Wind Electric Production and Wind Turbine Generator Manufacturing Facility; and
5. Coal Gasification Facility.

The survey elicited responses regarding historic and current county conditions, future developments, and socioeconomic data. This appendix describes the methodology utilized and details the survey responses. Tables also are presented which are representative of key questions and issues addressed in the questionnaire. The complete questionnaire is included in this Appendix.

D-1 Methodology

An attitudinal survey was prepared by MERDI in July 1978 to assess the opinions of Valley County residents about issues of growth and development associated with the various re-uses of GAFB.

The sample was selected randomly from the telephone directories representing Valley County, and 140 residents were sent letters of introduction explaining the significance of the survey. Interview appointments were scheduled by the interviewers, and the questionnaires were completed at the respondent's home or office. A completion rate of 71 percent provided statistical confidence of 95 percent (± 10 percent precision). Interviews began on August 2, 1978 and were completed on September 22, 1978.

The completed questionnaires were coded into Fortran format for keypunching onto computer cards. The data deck and data definition cards were mailed to Control Data Corporation in Boise, Idaho for analysis using the Statistical Package for the Social Sciences.

Key agencies and organizations in Valley County were requested to prepare letters stating how they could be impacted by the social factors involved with the various re-use scenarios (these responses were based on data supplied by a Standardized Information Document which provided a brief description of the various re-uses and the labor force required per phase), the regional marketability of the product, the pollution associated with each re-use, and the ownership of the various alternatives.

A similar technique was used to assess the possible impacts on the members of the Sioux and Assiniboine tribes residing on the Fort Peck Indian Reservation. The Tribal Council propared a letter of impact, which is included in Section 4 of Appendix E.

VALLEY COUNTY ATTITUDINAL SURVEY

THE MONTANA ENERGY AND MHD
RESEARCH AND DEVELOPMENT INSTITUTE, INC.

This is a questionnaire to determine the attitudes of Valley County residents toward issues that effect future developments in Valley County.

The survey has questions dealing with three areas.

(1) Historic and current county conditions;

(2) Future developments; and

(3) Socioeconomic data.

All individual responses are strictly confidential. Generalized trends and attitudes resulting from statistical analysis will be available to concerned groups and individuals.

Now a few questions dealing with historic and current county conditions.

1. Your years of residence in Valley County

		%	N
1.	Under 1 year	2	2
2.	More than 1, less than 3 years	3	3
3.	3 but less than 5 years	7	7
4.	5-10 years	17	17
5.	Much or all of my life	71	71
9.	Declined to respond	--	--

2. In your opinion which of the following characterizes the Valley County population (circle appropriate number)?

		%	N
1.	It has too few people.	34	34
2.	It has just the right number of people.	59	59
3.	It has too many people.	1	1
4.	Undecided	5	5
9.	Declined to respond	--	1

3. Indicate whether you agree, disagree, or are neutral about the following descriptions of living in Valley County.

	Agree		Disagree		Neutral		Don't Know		No Response	
	%	N	%	N	%	N	%	N	%	N
Job opportunities are good	37	37	53	53	8	8	-	1	-	1
People are my kind of people	89	86	3	3	7	7	-	-	-	4
Good shopping facilities	49	49	44	44	7	7	-	-	-	-

4. Which of the following was the main reason for your moving to Valley County? (Also ask for second and third most important reasons.)

	First		Second		Third	
	%	N	%	N	%	N
Always have lived here	51	51	-	-	-	-
Farming and/or ranching	2	2	28	8	28	2
Rural, spacious living atmosphere	4	4	28	8	42	3
Character of schools, churches	1	1	17	5	28	2
Business and job opportunity	32	32	17	5	-	-
Good land investment	1	1	-	-	-	-
Other	9	9	10		-	-
Not applicable			-	46	-	64
No response			-	25	-	29

5. Is your continued residence in Valley County dependent upon

	Yes		No		Don't Know		No Respons	
	%	N	%	N	%	N	%	N
Employment and job possibilities	41	35	58	49	1	1	-	15
Population size	15	12	84	66	1	1	-	21
Education offered to children	14	11	85	66	1	1	-	22
Security and enjoyment of life here	33	26	68	54	-	-	-	20
Maintenance of rural sense of community	28	23	70	57	1	1	-	19
None of these, i.e., not planning on leaving for any reason	56	51	43	39	1	1	-	9
Being able to afford staying	21	17	79	64	-	-	-	19
Improved social services	6	5	90	71	4	3	-	21
Other	14	10	84	58	1	1	-	31

6. How long do you plan to remain in the Valley County area?

		%	N
1.	1 year or less	4	4
2.	More than 1, but less than 3 years	5	6
3.	3 years or more, but less than 5 years	1	1
4.	5-10 years	5	5
5.	The rest of my life	65	65
6.	Don't Know	19	19
7.	Declined to respond	--	0

7. In Valley County which one of these services needs to be improved?

		%	N
1.	Schools	9	9
2.	Police	3	3
3.	Fire	1	1
4.	Health care	27	26
5.	Water/sewage	6	6
6.	Streets/roads	31	29
7.	City government	3	3
8.	County government	11	10
9.	None	2	2
10.	Don't Know	6	6
11.	Declined to respond	--	5

8. Which of these services would you be willing to support with more taxes?

		%	N
1.	Schools	20	19
2.	Police	-	-
3.	Fire	3	3
4.	Health care	6	6
5.	Water/sewage	1	1
6.	Streets/roads	19	18
7.	City/County government	3	3
8.	None	42	40
9.	Don't Know	-	4
10.	Declined to respond	6	6

9. What people or institutions are making plans and decisions about growth in Valley County (select the main one)?

		%	N
1.	City planning board	6	6
2.	County planning board	21	21
3.	State planning agency	3	3
4.	Industry	6	6
5.	Private agencies, such as Valley Industrial Park Incorporated	47	47
6.	The federal government	6	6
7.	Don't Know	11	11
8.	Declined to respond	--	0

10. How well are they doing it?

		%	N
1.	Adequately	56	56
2.	Inadequately	17	17
3.	It doesn't matter; planning is not effective	2	2
4.	Don't know	24	24
5.	Declined to respond	--	1

11. How satisfied are you with the public (i.e., your) input into these plans and decisions?

		%	N
1.	Satisfied	48	47
2.	Dissatisfied	17	17
3.	Neutral	27	27
4.	Don't know	7	7
5.	Declined to respond	--	2

12. How satisfied are you with Valley Industrial Park Incorporated's input into these plans and decisions?

		%	N
1.	Satisfied	43	43
2.	Dissatisfied	30	30
3.	Neutral	12	12
4.	Don't know	14	14
5.	Declined to respond		1

13. Below are listed a number of public services available to residents of Valley County. Please indicate your satisfaction with each of the following services.

	Satisfied		Dissatisfied		Neutral		Don't Know		No Response	
	%	N	%	N	%	N	%	N	%	N
Grade Schools	82	82	5	5	5	5	8	8	-	0
High School	78	78	11	11	3	3	8	8	-	0
Police protection	83	83	9	9	5	5	3	3	-	0
Hospital service	70	70	24	24	3	3	3	3	-	0
Ambulance service	70	70	10	10	2	2	18	18	-	0
Sewage service	70	68	7	7	2	2	20	20	-	3
Water supply system	65	62	15	14	4	4	16	16	-	4
Shopping facilities	47	47	46	46	6	6	1	1	-	0
Highways	53	53	40	40	5	5	2	2	-	0
County roads	43	43	46	46	5	5	6	6	-	0
Streets and street signs	78	78	16	16	3	3	3	3	-	0
Local government	71	71	12	12	12	12	5	5	-	0
Recreational facilities	75	75	18	18	4	4	2	2	-	1
Medical and dental services	52	52	44	44	2	2	2	2	-	0
Fire protection	88	88	4	4	3	3	4	4	-	1
Religious services	95	95	1	1	1	1	3	3	-	0
Garbage collection	64	60	10	9	3	3	23	22	-	6
Sanitary landfill facilities	74	73	6	6	2	2	17	17	-	2

This section deals with future development in Valley County. Many questions are entirely judgemental, so please make your best guess if you feel uncertain of the answer. There are no right or wrong answers.

14. Of the following consequences often associated with development, please indicate those which you feel might affect you and how.

	EFFECT									
	Major		Minor		None		Don't Know		No Response	
	%	N	%	N	%	N	%	N	%	N
Increased traffic on highways	14	14	36	36	50	50	-	0	-	0
Increased traffic on secondary roads	14	14	29	29	57	57	-	0	-	0
More persons using local gas stations, stores, laundromats, etc.	14	14	32	32	53	53	1	1	-	0
More diverse social and business possibilities	20	20	36	36	41	41	2	2	-	1
Increased home and land value	40	40	35	35	25	25	-	0	-	0
Improved services (fewer party lines, cable TV, etc.)	13	13	37	37	49	49	-	0	-	1
More domestic animals (dogs, cats, etc.)	21	21	50	50	26	26	2	2	-	1
More social organizations (little league, church, PTS, volunteer, etc.)	11	11	26	26	59	59	4	4	-	0

14. Of the following consequences often associated with development, please indicate those which you feel might affect you and how. (Continued)

	TYPE									
	Positive		Negative		Neutral		Don't Know		Not Applicable/ No Response	
	%	N	%	N	%	N	%	N	%	N
Increased traffic on highways	28	14	66	33	6	3	-	-	-	50
Increased traffic on secondary roads	30	13	61	26	9	4	-	-	-	57
More persons using local gas stations, stores, laundromats, etc.	73	35	21	10	6	3	-	-	-	52
More diverse social and business possibilities	95	53	2	1	1	1	2	1	-	44
Increased home and land values	52	39	44	33	1	1	3	2	-	25
Improved services (fewer party lines, cable TV, etc.)	90	45	6	3	4	2	-	-	-	50
More domestic animals (dogs, cats, etc.)	4	3	90	65	3	2	3	2	-	28
More social organizations (little league, church, PTA, volunteer, etc.)	80	32	7	3	10	4	3	1	-	60

15. Please indicate whether you agree, disagree, or are neutral on the following statements about growth in Valley Count.

	Agree		Disagree		Neutral		Don't Know		No Response	
	%	N	%	N	%	N	%	N	%	N
Rapid growth is good for the area and should be encouraged	17	17	73	72	8	8	1	1	-	2
As little growth as possible should be encouraged or allowed	13	13	83	83	3	3	1	1	-	0
Some growth is fine if it proceeds at a controlled rate	92	92	7	7	1	1	-	0	-	0
A person has a right to do with his land as he wishes even though it may affect the life-styles and preferences of others	40	39	55	53	4	4	1	1	-	3
Valley County has no choice about whether it will grow but only how it will grow	29	29	59	59	3	3	8	8	-	0

16. Please indicate whether the following have changed positively, negatively, nuetrally, or in ways not known in the past three years.

	Positively		Negatively		Neutrally		Don't Know		No Response	
	%	N	%	N	%	N	%	N	%	N
Employment opportunities	37	36	24	24	31	30	8	8	-	2
Land values (including housing costs)	49	48	33	33	7	7	11	11	-	1
Rural character of the area	17	17	12	12	62	61	9	9	-	1
Community services (schools, police)	39	39	7	7	50	49	4	4	-	1
Relation ships between groups of people	24	23	14	14	52	51	10	10	-	2
Natural and man-made recreational opportunities	53	52	8	8	35	34	4	4	-	2

17. How much control over what happens in Valley County do the residents have at present?

	%	N
1. Too much control	1	1
2. Adequate control	37	37
3. Not enough control	40	40
4. Don't know	22	22
5. Declined to respond	0	0

18. How much say should residents of the area have in what their neighbors do with their land?

		%	N
1.	Far more of a say	-	-
2.	More of a say	15	14
3.	They have enough of a say now.	48	46
4.	Less of a say	7	7
5.	Far less of a say	14	13
8.	Don't know	16	15
9.	Declined to respond	-	5

19. How would you categorize the following groups?

	Promoting Spontaneous Growth		Promoting Planned Growth		Promoting No Growth		No Involvement in Growth		Don't Know		No Response	
	%	N	%	N	%	N	%	N	%	N	%	N
County boards and County Commissioners	10	10	63	62	5	5	1	1	21	21	-	1
Large land holders	11	11	18	18	32	31	10	10	29	28	-	2
Real estate developers	33	33	38	37	4	4	1	1	24	24	-	1
Valley County School officials	4	4	52	51	1	1	20	20	23	23	-	1
Local residents	7	7	50	49	9	9	21	21	12	12	-	2
State agencies	9	9	50	49	4	4	5	5	32	32	-	1
Federal government	10	10	48	47	5	5	8	8	29	29	-	1
Other	8	1	58	7	8	1	8	1	17	2	-	88

The following section has several statements. Please indicate how you feel about each statement. Your feelings can range from strongly agreeing with the statement to strongly disagreeing. You may also agree, disagree or be neutral toward the statement.

	Strongly Agree		Agree		Neutral		Disagree		Strongly Disagree		No Response	
	%	N	%	N	%	N	%	N	%	N	%	N
1. New people coming into the county are always welcome because they bring with them many new ideas.	6	6	43	43	18	18	31	31	2	2	-	-
2. New people cause nothing but trouble; they should go back to where they came from.	1	1	5	5	5	5	64	64	25	25	-	2

		Strongly Agree		Agree		Neutral		Disagree		Strongly Disagree		No Response	
		%	N	%	N	%	N	%	N	%	N	%	N
3.	Meeting new people is enjoyable.	18	18	77	77	5	5	-	-	-	-	-	-
4.	The new values and ideas that might accompany newcomers to the community would be a welcome change.	13	13	64	64	15	15	8	8	-	-	-	-
5.	This community has a stability and closeness that would be destroyed by newcomers.	-	-	7	7	8	8	62	61	22	22	-	2
6.	The land in this county is best suited for farming and ranching	34	34	52	52	7	7	7	7	-	-	-	-
7.	Farming holds no future for our youth; they will have to find other employment if they are to succeed.	3	3	23	23	8	8	52	52	13	13	-	1
8.	If one has to destroy farm and range land to provide jobs, then so be it.	2	2	13	13	15	15	41	41	28	28	-	1
9.	For a job one must move from this community.	-	-	24	23	12	12	55	53	9	9	-	3

Question 19 Continued

	Strongly Agree		Agree		Neutral		Disagree		Strongly Disagree		No Response	
	%	N	%	N	%	N	%	N	%	N	%	N
10. The best day of my life will be the day I move out of this community	-	-	1	1	5	5	26	26	68	68	-	-
11. What I like most about living in this community is the pace of life.	20	20	58	57	11	11	9	9	1	1	-	2
12. Farmers and ranchers are the backbone of America.	25	25	48	48	19	19	8	8	-	-	-	-
13. Farming and ranching are okay, but I would not want to do either	4	4	19	19	5	5	48	48	24	24	-	-
14. It is possible to provide job opportunities and also keep a clean environment.	15	15	81	80	4	4	-	-	-	-	-	1
15. If the choice is between dirty air and my job, the answer is simple--dirty air.	-	-	7	7	15	14	64	60	14	13	-	6
16. It makes no sense to pollute our air or water to give an outsider a job.	13	13	56	54	22	21	8	8	1	1	-	3
17. The young in this community need jobs, and even if our air and water become polluted, those jobs should be provided.	-	-	21	20	20	19	47	45	12	11	-	5

		Strongly Agree		Agree		Neutral		Disagree		Strongly Disagree		No Response	
		%	N	%	N	%	N	%	N	%	N	%	N
18.	Solar energy is a foolish waste of time and money.	-	-	9	9	12	12	55	54	24	24	-	1
19.	The sun is a valuable, untapped source of energy that needs to be utilized.	27	27	62	62	6	6	5	5	-	-	-	-
20.	Wind energy will lower our dependence on fossil fuels.	6	6	62	61	24	24	8	8	-	-	-	1
21.	Use of coal and oil to generate electricity is unwise when there is so much sun and wind that will do the same job.	5	5	29	29	19	19	44	44	2	2	-	1
22.	If energy could be obtained from the wind and sun, private industry would already be doing it.	-	-	13	13	14	14	66	65	7	7	-	1
23.	Any industry that reduces this country's dependence on foreign energy sources is good.	9	9	75	74	6	6	9	9	1	1	-	1
24.	More uses need to be developed for this areas' agricultural products.	17	17	73	73	8	8	2	2	-	-	-	-

		Strongly Agree		Agree		Neutral		Strongly Disagree		Disagree		No Response	
		%	N	%	N	%	N	%	N	%	N	%	N
25.	Wheat or other grains can be turned into a valuable energy source.	10	10	74	72	14	14	2	2	-	-	-	2
26.	A good use of wheat is to convert it into a gasoline supplement	9	9	54	53	25	24	11	11	1	1	-	2

20. Which of the following are having the greatest effects on plans and decisions concerning growth? Rank many as you can. (Only the first three ranks are shown)

	1		2		3		Don't Know		No Response	
	%	N	%	N	%	N	%	N	%	N
County boards and county commissioners	55	41	17	13	9	7		6	-	25
Large land holders	28	12	16	7	16	7		6	-	57
Real estate developers	17	7	36	15	19	8		6	-	58
Valley County school officials	24		24	4	12	2		6	-	83
Local residents	16	5	26	8	13	4		6	-	69
State agencies	13	6	33	15	33	15		6	-	55
Federal government	29	16	31	17	20	11		6	-	45
Other (specify)	30	6	20	4	10	2		6	-	80

21. Which of these groups should have the greatest effects on plans and decisions concerning growth?

	1		2		3		Don't Know		No Response	
	%	N	%	N	%	N	%	N	%	N
County boards and county commissioners	43	29	43	29	4	3	9	6	-	32
Large land holders	14	2	14	2	7	1	43	6	-	86
Real estate developers	20	2	10	0	10	0	60	6	-	90
Valley County school officials	14	0	29	2	7	4	43	6	-	86
Local residents	51	51	9	9	2	2	6	6	-	32
State agencies	6	4	4	3	7	5	9	6	-	81

Question 21 Continued

	1		2		3		Don't Know		No Response	
	%	N	%	N	%	N	%	N	%	N
Federal government	13	2	13	2	13	2	40	6	-	85
Other (specify)	30	3	10	1	-	-	60	6	-	90

22. How much do you know about the various proposed reuses of Glasgow Air Force Base?

	%	N
1. Nothing	13	13
2. Vaguely familiar (have heard of it)	41	41
3. Know something about it	29	29
4. Quite familiar	16	16
9. Declined to respond	-	1

23. Of those in your household who are salaried or self-employed (including you and your spouse) what type of work is each one doing?

OCCUPATION	YOU		SPOUSE		OTHER FAMILY MEMBER	
	%	N	%	N	%	N
Professional	20	16	25	13	8	1
Manager or administrator	14	11	13	7	-	-
Sales	3	2	4	2	-	-
Clerical	11	9	12	6	8	1
Craftsman	5	4	12	6	15	2
Operative	3	2	-	-	-	-
Laborer (except farm)	12	10	13	7	15	2
Farmer/Farm Manager	25	20	13	7	31	4
Farm labor	1	1	-	-	15	2
Service Worker	5	4	8	4	8	1
Transport Operative	1	1	-	-	-	-
Not Applicable	-	19	-	35	-	61
No Response	-	1	-	13	-	26

24. How much effect do you think developments at Glasgow Air Force Base would have upon your family's employment and/or income within the next five years? (Specify if different for income than for employment).

	None		Very Little		Moderate		A Great Deal		Don't Know		No Response	
	%	N	%	N	%	N	%	N	%	N	%	N
Employment	53	51	14	13	11	11	19	18	3	3	-	4
Income	30	30	19	19	15	15	31	31	4	4	-	1

25. Would this effect be positive or negative?

	%	N
Positive	76	48
Negative	6	4
Overall, neither positive or negative	16	10
Don't Know	2	1
Declined to respond	-	7
Not applicable	-	30

26. Please explain how you feel this would affect your family income and/or employment.

	%	N
Lose job	3	2
Job opportunity	28	16
Raise income	26	15
Raise income at GAFB	9	5
Part-time job	2	1
Bust-boom reaction	3	2
No connection with GAFB	2	1
Improve services	2	1
Improve business	17	10
Raise taxes	2	1
Raise standard of living	2	1
Raise prices	3	2
Farm help	2	1
Not applicable	-	33
No Response	-	9

27. If 100 families (400 to 500 people) move into the Valley County during the next five years, what effect would that have on the following?

	Positive		Negative		No Effect		Don't Know		No Response	
	%	N	%	N	%	N	%	N	%	N
Job opportunities	61	59	26	25	6	6	7	7	-	3
Natural and man-made recreational opportunities	38	37	30	29	25	23	8	8	-	3
Enjoyment of life in general	24	23	14	14	53	51	9	9	-	3
Feelings toward Valley County	25	24	8	8	61	58	5	5	-	5
Feelings of being a part of the Valley County Community	23	22	7	7	63	60	7	7	-	4
Feelings of security	22	21	19	18	49	47	10	10	-	4
Taxes	30	29	24	23	24	23	22	21	-	4

28. Valley County could adequately absorb 100 new families.

	%	N
1. Even if the increase occurs immediately	38	38
2. If the increase is spread over 5 years	42	42
3. If the increase is spread over 10 years	6	6
4. If the increase is spread over 15 years	1	1
5. If the increase is spread over 20 years	1	1
6. If the increase is spread over more than 20 years	1	1
7. None of the above because the area cannot absorb that amount	5	5

	%	N
8. Don't know	6	6
9. Declined to respond	-	

29. If the 100 families move in, how would each of the following be affected?

	Positively		Negatively		Not Affected		Don't Know		No Response	
	%	N	%	N	%	N	%	N	%	N
Grade schools	45	45	26	26	26	26	2	2	-	1
High school	43	43	26	26	26	26	4	4	-	1
Police protection	17	17	33	33	37	37	11	11	-	2
Hospital services	39	39	17	17	38	38	5	5	-	1
Ambulance service	22	22	17	17	49	49	11	11	-	1
Sewage service	7	/	24	24	46	46	21	21	-	2
Water supply	9	9	30	30	45	45	14	14	-	2
Shopping facilities	44	44	19	19	33	33	3	3	-	1
Highways	13	13	23	23	56	56	7	7	-	1
County roads	8	8	33	33	46	46	11	11	-	2
Streets and street signs	10	10	16	16	65	64	8	8	-	2
Recreation facilities	26	26	31	31	36	36	5	5	-	2
Dental and medical services	27	27	36	36	30	30	5	5	-	2
Fire protection	15	15	22	22	55	54	7	7	-	2
Religious services	24	24	8	8	63	62	4	4	-	2
Garbage collection	14	14	16	16	50	49	19	19	-	2
Sanitary landfill facilities	11	11	20	20	50	49	18	18	-	2

30. If 250 families (at least 1,000 people) move into Valley County in the next two years, which of the following items would be most affected (select one)?

	%	N
1. Housing costs	28	27
2. Other living costs	2	2
3. Employment opportunities	13	13
4. Recreational opportunities	1	1
5. Community services (e.g., schools, police)	8	8
6. Relationships between groups of people	3	3
7. Housing availability	42	41
8. Health-related services	2	2
9. Declined to respond		2
10. Don't know	1	1

31. Would Valley County be affected for the better or worse?

	%	N
1. Better	48	47
2. Worse	38	37
3. Neither better nor worse	8	8
4. Don't know	6	6
5. Declined to respond	-	2

32. If 250 new families (i.e., at least 1000 people) move into Valley County during the next two years, the increased cost of services should be paid by the industry that employs the new families.

	%	N
1. Agree	39	39
2. Disagree	39	39
3. There will be no increased cost	6	6
4. Neutral	15	15
5. Declined to respond	-	1

33. If 100 families move into the Valley County area in the next five years, would you agree, disagree, or be neutral toward the following statements?

	Agree		Disagree		Neutral		Don't Know		No Response	
	%	N	%	N	%	N	%	N	%	N
The excitement that the new influx of people might bring would be welcomed	57	56	22	21	18	17	3	3	-	3
Area residents would have to pay more taxes for schools	44	44	43	43	5	5	7	7		1
The price of housing and land would go up sharply	66	65	26	26	5	5	3	3	-	1
The Valley County area could adequately handle that many people	87	86	7	7	1	1	4	4	-	2
The newcomers would be easily accepted into the community in that time span	70	69	17	17	7	7	5	5	-	2
The Valley County area would be a better place to live	40	39	16	16	31	30	12	12	-	3
You would consider moving from the area	5	5	90	89	3	3	2	2	-	1

34. If 100 families (at least 400 people) move into Valley County, would you agree, disagree, or be neutral toward the following statements?

	Agree		Disagree		Neutral		Don't Know		No Response	
	%	N	%	N	%	N	%	N	%	N
There would be more jobs in Valley County	63	60	23	22	8	8	6	6	-	4
All of us would have to pay more taxes for schools	44	34	47	35	2	2	8	6	-	23

	Agree		Disagree		Neutral		Don't Know		No Response	
	%	N	%	N	%	N	%	N	%	N
Local people would still control decisions	71	70	17	17	5	5	6	6	-	2
Valley County would be a better place to live	39	29	19	14	34	25	8	6	-	26
The newcomers would be easily accepted into the community	57	42	23	17	15	11	5	4	-	26
The price of housing would go up sharply	68	51	24	18	5	4	3	2	-	25
Valley County could han handle that many more people	83	62	8	6	4	3	5	4	-	25

35. Would you like a coal gasification plant located in Valley County?

YES		NO		DON'T KNOW		NO RESPONSE	
%	N	%	N	%	N	%	N
47	46	38	38	15	14	-	2

36. Would you like a coal-fired steam electric plant in Valley County?

YES		NO		DON'T KNOW		NO RESPONSE	
%	N	%	N	%	N	%	N
48	47	37	37	14	14	-	2

37. Would you like a gasahol plant in Valley County?

YES		NO		DON'T KNOW		NO RESPONSE	
%	N	%	N	%	N	%	N
69	68	24	24	7	7	-	1

38. Would you like a solar house manufacturer in Valley County?

YES		NO		DON'T KNOW		NO RESPONSE	
%	N	%	N	%	N	%	N
82	80	7	7	11	10	-	3

39. Would you like a manufacturer of wind generators in Valley County?

YES		NO		DON'T KNOW		NO RESPONSE	
%	N	%	N	%	N	%	N
84	82	7	7	9	8	-	3

40. Would you like a railroad repair facility loacted in Valley County?

YES		NO		DON'T KNOW		NO RESPONSE	
%	N	%	N	%	N	%	N
73	70	16	16	11	11	-	3

41. Rank the following economic activities as to the one you would like most to locate in Valley County. Rank first and second choice and those opposed to.

	First		Second		Third		Don't Know		No Response	
	%	N	%	N	%	N	%	N	%	N
Coal gasification plant	8	8	6	6	3	3	3	3	-	77
Coal-fired steam electric plant	7	7	6	6	3	3	3	3	-	80
Gasohol plant	25	25	9	9	3	3	3	3	-	80
Solar house manufacturer	16	16	22	22	1	1	3	3	-	59
Wind generator manufacturer	6	6	20	20	1	1	3	3	-	56
Railroad car repair facility	12	12	11	11	3	3	3	3	-	69
Other (see below)	-	-	-	-	-	-	-	-	-	86

	%	N
Vo-Tech	5	1
Mushroom factory	11	2
Flour mill	5	1
Clean industry	16	3
Hires most people	5	1
Boeing	21	4
Social services	11	2
Community college	21	4
Nuclear reactor	5	1
No Response		81

	Oppose		Don't Oppose		Don't Know		No Response	
	%	N	%	N	%	N	%	N
Coal gasification	39	37	54	51	7	7	-	5
Coal-fired steam	37	35	56	53	7	7	-	5
Gasohol	17	16	75	72	8	8	-	4
Solar house manufacturer	6	6	85	81	8	8	-	5
Wind generator	4	4	88	84	8	8	-	4
Railcar repair	6	6	84	81	8	8	-	5

This section asks for some personal background information. This information is very important to the overall study so please be as open as possible when responding. All responses will be held in strict confidence.

42. Sex:

Male	60
Female	40
Declined to respond	-

43. What is your age?

AGE	NUMBER
21	3
24	1
26	1
27	1
28	2
29	3
30	4
31	2
32	5
33	1
34	2
35	3
36	3
37	1
38	1
39	1
40	1
41	1
42	2
43	2
46	2
47	2
48	4
49	3
50	3
51	6

MEAN = 47.85

Question 43 Continued

AGE	NUMBER
52	4
54	5
57	5
58	3
59	1
60	1
62	6
63	1
64	2
65	1
66	2
67	1
68	1
69	1
71	3
76	1
86	1
106	1

44. How many years of schooling have you completed?

MEAN = 12.39

YEARS OF SCHOOL	NUMBER
0	1
3	1
4	1
6	1
8	9
9	4
10	3
11	3
12	40
13	6
14	8
15	4

Questions 44 Continued

YEARS OF SCHOOL	NUMBER
16	6
17	4
18	5
19	2
21	1
No Response	1

45. How many members of your household fall in the following age groups?

	0	1	2	3	4	No Response
0-5	78	14	6	-	-	2
6-14	62	15	17	4	-	2
15-18	75	16	8	-	-	1
19-29	69	15	9	3	2	2
30-39	68	10	20	-	-	2
40-49	74	15	9	-	-	2
50-59	67	18	14	-	-	1
60-69	76	13	9	-	-	2
70 and over	91	4	3	-	-	2

46. How many family members (age 16 and over) are unemployed or retired?

	Number of Households		
	0	1	2
Number unemployed	97	1	2
Number retired	84	7	9

47. Marital status of respondent

	%	N
Married, no dependent children	35	35
Married, dependent children	50	50
Not married, no dependent children	12	12
Not married, dependent children	3	3
Declined to respond	-	-

48. Type of home	%	N
Separate single family home	80	80
Apartment, including duplex-fourplex	12	12
Mobile home (mobile home park)	3	3
Mobile home on private lot	5	5
Other	-	-
Declined to respond	-	-

49. Do you or does head of household own or rent your residence?

	%	N
Own	73	73
Rent/lease	27	27
Declined to respond	-	-

50. Which of the following categories is representative of your total annual family income before taxes?

	%	N
$0 - $4,999	3	3
$5,000 - $8,999	18	17
$9,000 - $12,999	12	11
$13,000 - $16,999	16	15

Question 50 Continued

	%	N
$17,000 - $24,999	23	22
$25,000 - $35,000	16	15
More than $35,000	12	11
Don't know	1	1
Declined to respond	-	5

RESULTS OF VALLEY COUNTY ATTITUDINAL SURVEY

Figures are rounded off to nearest percentage points; percentages are adjusted to reduce influence of no response.

RESIDENCE

The years the respondents have lived in Valley County is shown in Table 1.

Table 1.--Years of Residence

	%	N
Under 1 year	2	2
More than one year, less than three	3	3
Three but less than five	7	7
Five to ten	17	17
Much or all of my life	71	71

Reasons for continuing to reside in Valley County are presented in Table 2.*

Table 2.--Resident's Reasons

	Yes		No		Don't Know	
	%	N	%	N	%	N
Employment	41	35	58	49	1	1
Population size	15	12	84	66	1	1
Education for children	14	11	85	66	1	1
Security and enjoyment of life	33	26	68	54	-	-
Maintenance of a rural sense of community	28	23	70	57	1	1
None of these-not planning on leaving	56	51	43	39	1	1
Being able to afford staying	21	17	79	64	-	-
Improved social services	6	5	90	71	4	3

SERVICES

Respondents were asked which service most needed to be improved in Valley County. These results are presented in Table 3.

Table 3.--Service Improvement

	%	N
Schools	9	9
Police	3	3
Fire	1	1
Health care	27	26
Water/sewage	6	6
Streets/roads	31	29
City government	3	3
County government	11	10
Satisfied	2	2
No response	6	5

DECISIONS

Those people or institutions considered by the sample to be the main decision-makers in Valley County are shown in Table 4.

Table 4.--Decision Makers

	%	N
City planning board	6	6
County planning board	21	21
State planning agency	3	3
Industry	6	6
Private agencies (VIP)	47	47
Federal government	6	6
Don't know	11	11

The sample was asked how satisfied they were with Valley Industrial Park's input into plans and decisions for the County. These results are shown in Table 5.

Table 5.--Satisfaction with VIP

	%	N
Satisfied	43	43
Dissatisfied	30	30
Neutral	12	12
Don't know	14	14
No response	-	1

FUTURE DEVELOPMENT

The most significant change of future development foreseen by the sample was increased home and land values. Table 6 shows these results.

Table 6.--Effect and Type of Increased Home and Land Values

EFFECT	%	N
Major	40	40
Minor	35	35
None	25	25
TYPE		
Positive	52	39
Negative	44	33
Neutral	1	1
Don't know	3	2
No response	-	25

GROWTH

The results of the survey response to issues concerning growth are presented in Table 7.

Table 7.--Attitudes of Growth

	Agree		Disagree		Neutral	
	%	N	%	N	%	N
Rapid growth is good for the area and should be encouraged.	17	17	73	72	8	8
As little growth as possible should be encouraged or allowed.	13	13	83	83	3	3
Some growth is fine if it proceeds at a controlled rate.	92	92	7	7	1	1
Valley County has no choice about whether it will grow; only how it will grow.	29	29	59	59	3	3

CHANGE

The sample was asked to address several issues concerning change. These results are presented in Tables 8 through 11.

Table 8.--Attitudes Toward New People

	Agree		Disagree		Neutral	
	%	N	%	N	%	N
New people coming into the county are always welcome because they bring with them many new ideas.	49	49	33	33	18	18
This community has a stability and closeness that would be destroyed by newcomers.	7	7	84	83	8	8

Table 9.--Attitudes Toward Farming and Employment

	Agree		Disagree		Neutral	
	%	N	%	N	%	N
Farming holds no future for our youth; they will have to find other employment if they are to succeed.	26	26	65	65	8	8
If one has to destroy farm and range land to provide jobs, then so be it.	15	15	69	69	15	15

Table 10.--Attitudes Toward Environment and Employment

	Agree		Disagree		Neutral	
	%	N	%	N	%	N
It is possible to provide job opportunities and also keep a clean environment.	96	95	-	-	4	4
It makes no sense to pollute our air and water to give an outsider a job.	69	67	9	9	22	21
The young in this community need jobs, and even if our air and water become polluted, these jobs should be provided.	21	20	59	56	20	19

Table 11.--Attitudes Toward Energy Use

	Agree		Disagree		Neutral	
	%	N	%	N	%	N
The sun is a valuable source of energy that needs to be utilized.	89	89	5	5	6	6
Use of coal and oil is unwise when there is so much sun and wind that will do the same job.	34	34	46	46	19	19
A good use of wheat is to convert it to a gasoline supplement.	63	62	12	12	25	24

Those people surveyed were asked how developments at Glasgow Air Force Base would affect their employment and income opportunities during the next five years. These results are shown in Table 12.

Table 12.--Air Base Effects on Employment and Income

	NONE		VERY LITTLE		MODERATE		A GREAT DEAL		DON'T KNOW		NO RESPONSE	
	%	N	%	N	%	N	%	N	%	N	%	N
Employment	53	51	14	13	11	11	19	18	3	3	-	4
Income	30	30	19	19	15	15	31	31	4	4	-	1

Table 13 shows how those surveyed felt various aspects of life would be affected by 100 families moving into Valley County during the next five years.

Table 13.--Affects of 100 Families Moving into Valley County

	Positive		Negative		No Affect	
	%	N	%	N	%	N
Job opportunities	61	59	26	25	6	6
Recreation opportunities	38	37	30	29	25	23
Enjoyment of life	24	23	14	14	53	51
Feelings toward Valley County	25	24	8	8	61	58
Feeling of being a part of the Valley County community	23	22	7	7	63	60
Feelings of security	22	21	19	18	49	47
Taxes	30	29	24	23	24	23

The questionnaire addressed the various reuse scenarios by asking the respondents if they approved or disapproved of them. Table 14 presents these results.

Table 14.--Opinions of the Reuse Scenarios

	YES		NO		DON'T KNOW	
	%	N	%	N	%	N
Coal gasification plant	47	46	38	38	15	14
Steam-fired electric plant	48	47	37	37	14	14
Gasohol plant	69	68	24	24	7	7
Solar house manufacturer	82	80	7	7	11	10
Wind generator manufacturer	84	82	7	7	9	8
Railcar repair facility	73	70	16	16	11	11